THE UNIVERSITY OF MEMPHIS

The Center for Research in Educational Policy (CREP)

The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education

Summative Report Section 7:

Case Studies

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Case Studies Overview

This summary provides a general overview of key themes and lessons learned from case studies for the LASER i3 implementation, with a focus on a subset of Phase 1 schools. Site visits in these schools were conducted in the Spring of 2013, and again in Spring 2014; data collected, analyzed, and reported were primarily from school administrator and teacher interviews during those site visits. Four to five schools from each region were selected for case study analysis – a total of 14 Phase 1 sites. Three of these schools were categorized as "non-traditional" because of distinct educational approaches adopted prior to LASER i3. In order to protect the anonymity of interviewed school personnel, schools are referenced throughout this report by pseudonyms (e.g., NM-A; HISD-C). See Figure 6 for a list of these schools.

This overview presents key "take-aways" from the case studies – **general themes** that describe the case study schools' overall experience with the LASER i3 implementation, as well **lessons learned**: challenges and successes, addressed by specific schools in the case studies.

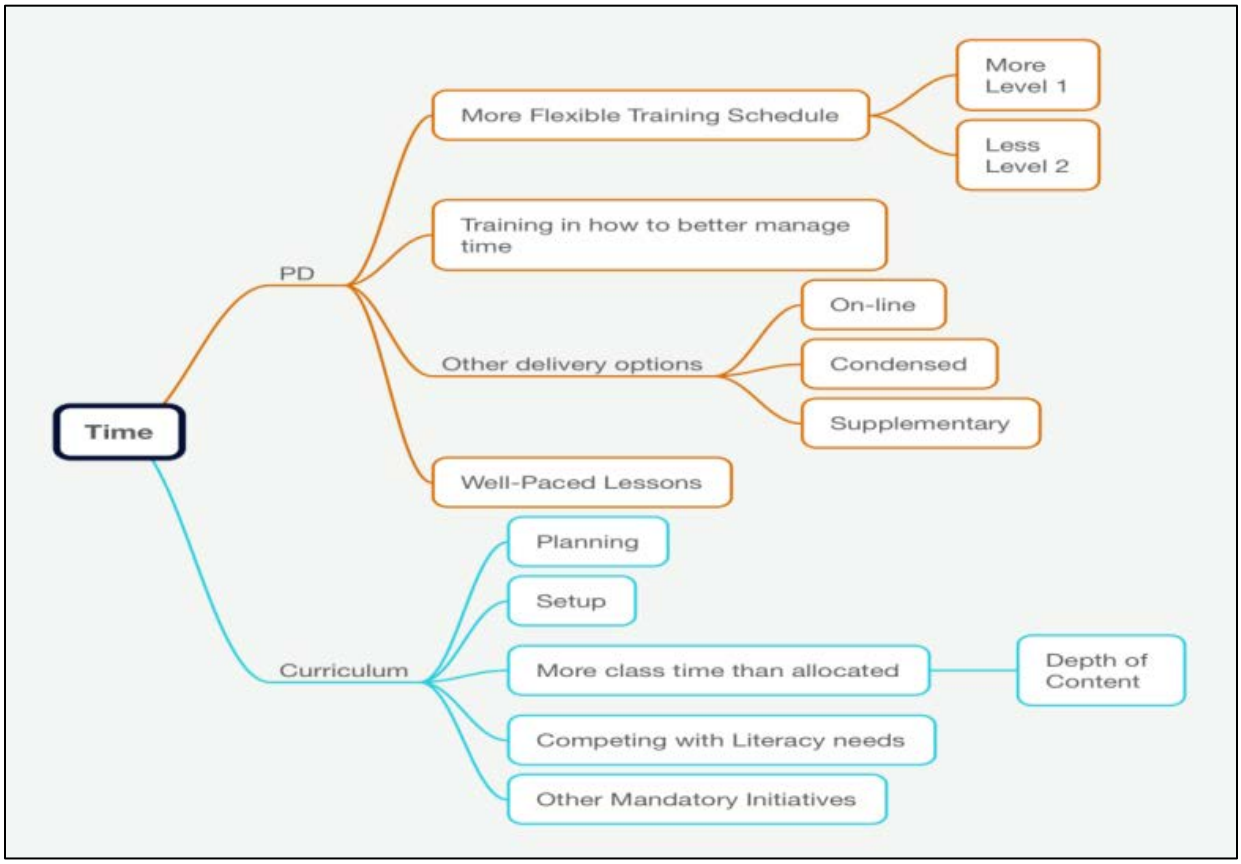
General Themes

As the high-level findings were being analyzed and reported, several themes began to emerge. Figures 1 through 4 provide some general themes, which could be derived from the findings: *available time, alignment, support,* and *student impact.*

Available time (Figure 1) was a common theme for nearly every case study school. With regard to available time for professional development, teachers expressed a preference for more flexibility in scheduling, as well as alternative delivery channels (e.g., online). Though teachers with little science background could benefit from the level 2 training, teachers with a stronger science background felt that they might benefit more by focusing on the implementation of the science units (i.e., Level 1 training). Teachers were also faced with time issues concerning

planning, setup, and instruction, with the depth of content covered directly impacted by instructional time allocated. Moreover, teachers had to juggle time spent on science with district requirements for priorities such as literacy.

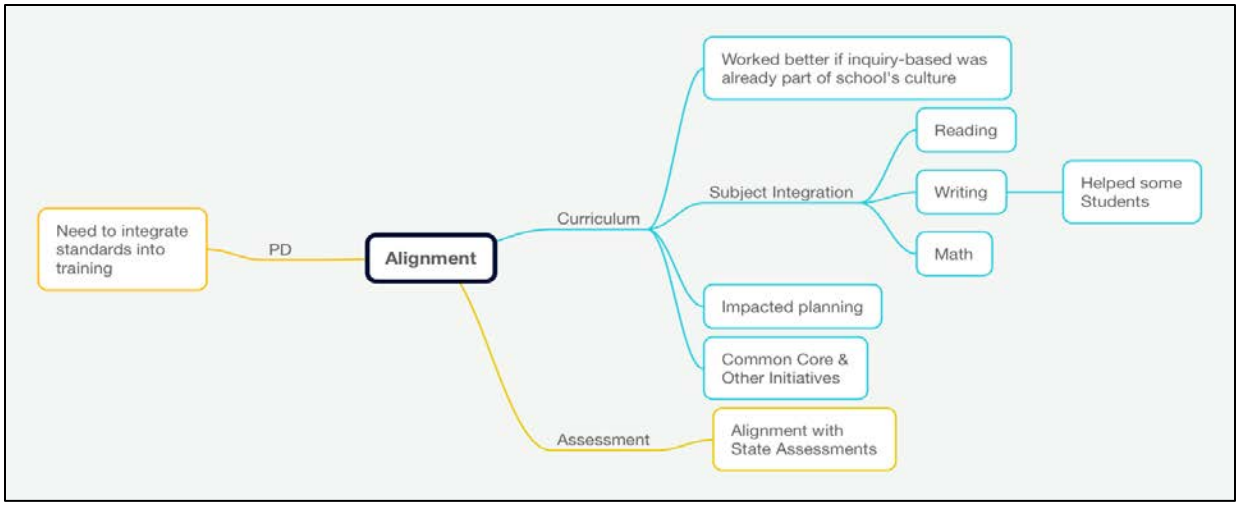
Figure 1: Available Time



Alignment (Figure 2) of the LASER program with the curriculum and other initiatives emerged as a common theme. Issues with alignment included how to integrate the program within the school's unique environment, as well as ensuring that content matched that required for mandatory assessments. Schools that already had a focus towards inquiry-based learning were more easily able to integrate LASER into the existing curriculum. In some instances, teachers were able to incorporate the science learning within other subjects (e.g., using the

science lesson as part of the reading lesson). When used effectively, teachers reported that the science lessons helped students with writing skills.

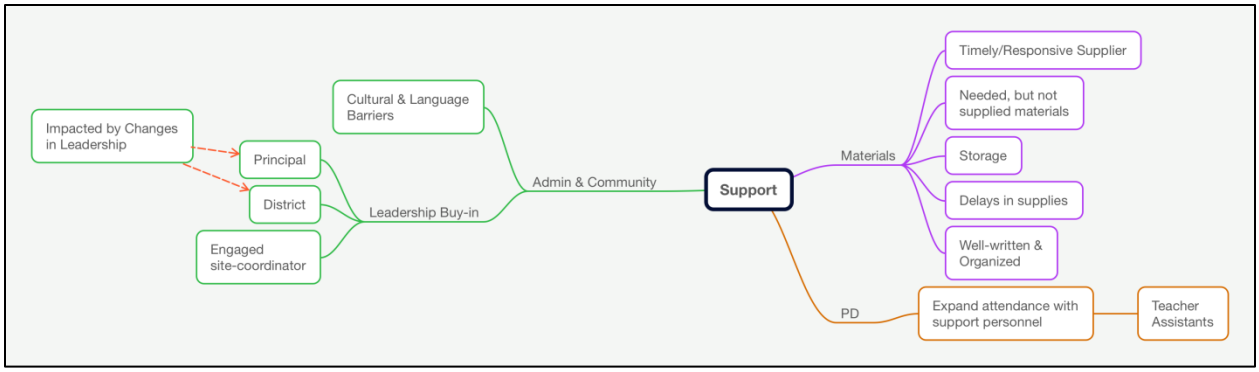
Figure 2: Alignment



Besides expanding professional development attendance, beyond teachers, ***Support*** (Figure 3) followed two primary pillars: Administrative & Community, and Materials. Most comments were positive regarding the quality of the materials provided for science instruction; however, the general procurement, and particularly, the storage of materials were discussed as topics that schools would need to address if the program is to be sustained.

During the course of the project, some districts/schools experienced changes in leadership, and this had an impact on support. Moving forward, staff often expressed that "leadership buy-in" was necessary for the continued success of the program. Finally, a community support issue, which was particularly evident in New Mexico, was that schools needed to address cultural perceptions of education and science, as well as bilingual issues.

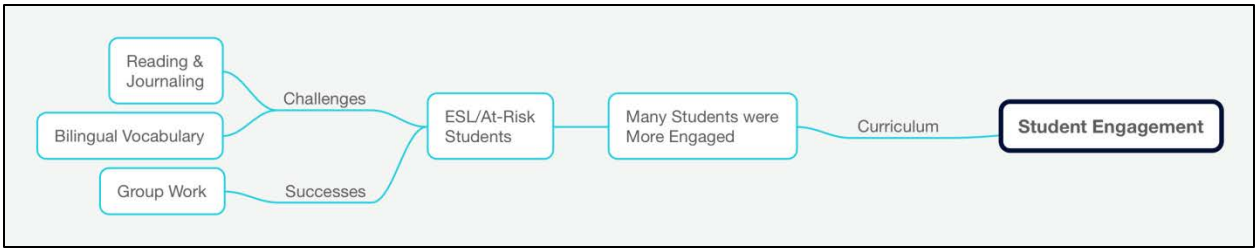
Figure 3: Support



It was common for staff to talk about ***student engagement*** (Figure 4) and how enthusiastic all students were during the science lessons. Interestingly, LASER had the most noticeable impact on ESL students as well as at-risk students. Not only were they more engaged during science than in other subjects, but there were also reports that group work was more effective for these students. However, there were still challenges with these students, particularly concerning reading at grade-level and limited science vocabulary.

Again, teachers indicated that the hands-on activities engaged students, and proved to be especially beneficial for keeping at-risk and ESL students involved. It is likely that it was not only the hands-on aspect of the activities, but also the group learning that students were responding to positively. Specifically addressing group dynamics and the research surrounding particular group learning environments should aid teachers in becoming more purposeful about grouping students in the future to maximize learning and engagement, depending on student characteristics and the goals the teachers hope to accomplish (i.e., language acquisition, on-task behavior, or critical thinking).

Figure 4: Student Engagement



Lessons Learned

Within the context of project-wide themes there have been important lessons learned through the experiences of the case study schools. The following segment explores lessons learned through several perspectives: *the community and students*, *the curriculum*, and *the school*.

The Community and Students

When initiating a new program, it is important to consider aspects of the community, as well as the types of students being served. Implemented in three very different regions, this project offered the opportunity to consider the impact of local culture, language, and the needs of special students and to adjust the program accordingly.

The level of community/family engagement/support for LASER was clearly influenced by the overall perception of science (and even education in general) supported by the local culture. For example, school NM-D, which served a more affluent and science-oriented community, had a not surprisingly more engaged and successful experience with LASER i3 than other schools who found engagement of parents and the larger community to be a challenge. Primarily from a traditional Hispanic community, NM-C students were reported to be less college- or career-minded, encouraged to be more focused on starting a job and family obligations. Native American students from NM-E had an even greater disconnect between their community values and education/science. A very community-oriented culture, it was important

for these families that education had a direct, real-world contribution to their families and pueblo. If they could not see the direct and immediate benefit of education for their local community, they struggled with understanding its value.

In the Native American culture, students are taught that elders are not to be questioned, making introduction of inquiry-based strategies challenging. One way that NM-E teachers dealt with this cultural issue was through group lessons, which included problems addressing real-life situations. Another way to address this issue was to engage parents in discussions about the science lessons, to help families better understand what is being taught, how it can be applied, and the value of encouraging questioning and critical thinking. The local culture also impacted the extent to which language became a barrier in the learning process. STC units were designed to be taught in English; however the commitment to learning English varied across schools, regions, and cultures. For example, NM-A families wanted their children to retain the language of their heritage and chose to enroll their students in 45-minutes of daily instruction in either Spanish or their family's native language. HISD-C teachers dealt with the language barrier by introducing the science lesson in Spanish, but then translating it into English, which they believed might have also helped with the students' English acquisition. Some schools (i.e., HISD-E, NT-B, and NM-C) found that reading and vocabulary were a particular problem for younger students. At HISD-E, the teachers of younger grades (1^{st}-3^{rd}) typically taught and tested the students in Spanish; gradually, introducing English terminology.

LASER i3 was implemented in schools with high percentages of students considered at-risk because of economic disadvantage or other conditions beyond language issues. Several case study schools (i.e., NM-A, NM-D, NC-A, NC-B, NC-C, and NC-E) mentioned the effectiveness of LASER i3 for at-risk students. More specifically, hands-on learning and group work seemed

to help these students become more engaged in science. Staff from the NM-C school reported that it helped to group students, who understood the lesson, with ELL and at-risk students. Both NM-E and NC-A mentioned the grouping of struggling students with high-performing students, who could explain concepts for them.

The Curriculum

All regions had initiatives and requirements beyond LASER i3 that competed for available time. Generally, it was not uncommon for staff to report the challenge of implementing a new science initiative, while still meeting the demands of other, mandatory, standards (e.g., Common Core, Next Generation Science Standards) and core subjects (e.g., reading/language arts, math). Science was typically secondary to reading and math because high-stakes testing was attached to those subjects. If a school was not doing well in one or more of the core subjects, the demands for focus on those areas became even higher (e.g., HISD-C, HISD-E, and North Carolina). However, there were some schools that were better able to integrate these demands with the LASER i3 curriculum.

The integration of STC units with literacy through readers and journaling was reported at several North Carolina schools, and staff at NC-B specifically noted that the science lessons integrated well with reading. Some schools used the science lesson as part of their reading, integrating the reading lesson with science (e.g., experiments) at a different part of the day. NM-E literacy teachers reported using vocabulary provided by the science teacher to frame their lessons.

Because of a high focus toward reading initiatives at school NC-C, science was no longer taught as its own subject, but was integrated with reading and science journaling provided opportunity for students to write.;. At NC-B, teachers thought that the science journals

supported the literacy initiatives (i.e. Read to Achieve), as well as developing students' writing skills.

Teachers at NC-E school suggested that it would have helped them if the literacy components from the STC units could have been more intentionally connected to other subjects. As further explained in the limitations and considerations section of this report, case study schools whose students did well in state reading assessments (i.e., NM-D; NT-A) showed similar performance-levels in open-ended/performance-task measurements; the same pattern was seen for low-performing schools (i.e., HISD-E; NM-A). Overall, case study findings support continued emphasis on the integration of reading/writing with the science lessons within the LASER i3 materials and on helping teachers make these connections through professional development.

Integration of LASER i3 into the school's curriculum appeared to be better in general if inquiry-based learning was already part of the school's culture and if the STC curriculum clearly aligned with the current state and/or district standards. Specifically, all of the schools in the Non-Traditional set had some level of inquiry-based learning as a part of their curriculum prior to LASER i3; therefore the transition was more seamless and the level of teacher engagement generally higher. In the initial implementation of an inquiry-based program, it would be useful to provide a high-level assessment of how inquiry-based learning is already used in the school, and adjust PD and materials accordingly.

The School

Beyond alignment with standards and curriculum, it is also useful to understand additional factors that are unique or challenging about the overall school environment. For example, the NT-C school offered a unique challenge: because multiple grades met together as

one class (i.e. first, second, and third; fourth, fifth, and sixth), it was difficult to teach grade/age-specific lessons from the standard material. Going forward, schools in this or similar situations will need assistance in determining how best to select units and strategies for overlapping grade/age levels.

Another aspect of the school that affects the success of a new science initiative is how science teaching is organized. Specifically, teachers with more dedicated time to devote to science (e.g., departmentalization for science; dedicated science teachers, particularly in middle schools) and common resources for science (e.g., a dedicated lab) reported fewer issues, particularly, with available time. In cases where a departmentalized approach could not be used, sharing of resources and team teaching was occasionally done. For example, HISD-B started more grade/school-level planning sessions for science. Teachers from NC-C and NC-E addressed resource/time constraints by teaching all of their students in a grade at the same time - students would work in groups of four during an experiment, while the teachers and their assistants would walk around and visit groups to assess learning and answer questions.

A school/district's commitment, as well as changes in leadership, also impacts the success and acceptance of a new program; a new superintendent or principal often means a change in focus and commitments. Changes in overall teaching staff are also likely to have an effect. For example, during the course of the project, NM-C had a high staff/leadership turnover, as well as a practice of shifting teachers to different grades/subjects. In the end, there was little investment in the LASER i3 program for this school.

The assignment of the site coordinator is also critical for success at the school level. Ideally, the site coordinator will have some experience/perspective for teaching science, as well as occupy a leadership role at the school (i.e. lead teacher, curriculum instructor, science

coordinator). Also, for the continuity of support/learning, if possible, the site coordinator should continue to drive the program over the long-run. For example, HISD-E had to reassign its site coordinator in the projects third year, to a first year teacher, who admitted that the program might not have been getting its required attention at that point because she was new to the school and unfamiliar with the project. In fact, it can be said that the selection of and support for the site coordinator has a direct impact on quality of implementation and serves as a barometer for overall school-level support for the program.

Case Studies Report

Background

Although the LASER i3 implementation evaluation was not primarily a case study-centered project, case studies were used to further understand the experience of inquiry-based science education for a sample of those schools that received the LASER model (treatment) and to identify challenges and successes which could inform LASER implementation on a broader scale. Stake's (2006) design for multi-site case studies was used to inform the framework in planning and reporting case studies used in this evaluation.

Timeline

After reviewing a year of data (2011-2012), it was determined which case study schools would be a part of the evaluation. Site selection was completed in Fall 2012 and the first set of school site visits were conducted in Spring 2013. Basic findings from these interviews were analyzed in Summer 2013. Before visiting the schools for a second time, the data analysis from the first set of interviews was used to revise/add questions for the second set of interviews.

The second site visits were completed between Fall 2013 and Spring 2014. In addition, a few Phase 2 sites from each region were also selected based on initial positive findings about science instruction and/or student achievement. These sites were also visited in Spring 2014 with interview questions tailored to better understand these findings. The results from all of the interviews were analyzed in Fall 2014 through Spring 2015. Table 1 provides an overview of the timeline.

Table 1: Case Study Timeline

	2012	2013			2014			2015	
	F	Sp	Su	F	Sp	Su	F	Sp	Su
Phase 1 Site Selection									
Protocol Development									
Site Interviews									
Analyze Site Interviews									
Refine Protocol for Second Site Visit									
Phase 2 Site Selection									
Final Case Study Reports									

Method: Site Selection

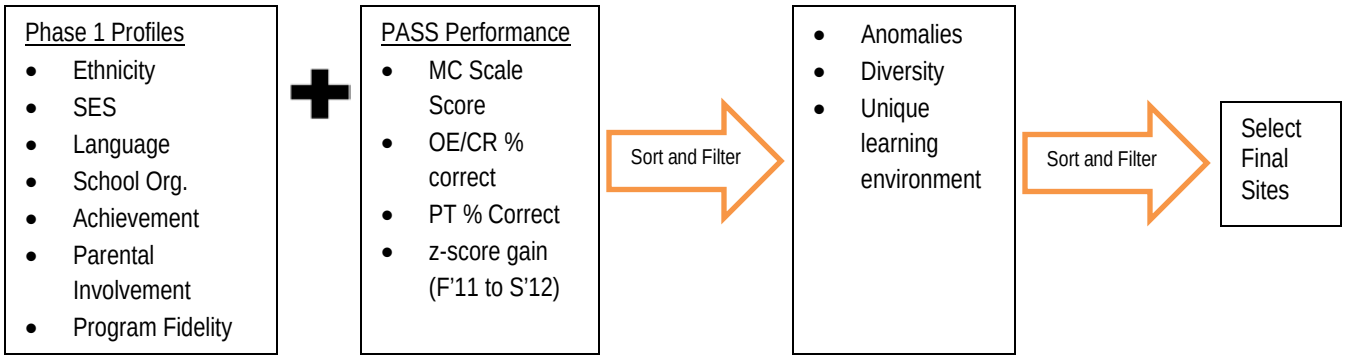
For each region (New Mexico, Houston, and North Carolina), a small sample of schools was purposefully selected, based on a set of indicators. First, profiles were developed for all Phase 1 schools using the following data:

- Ethnicity
    - % of American Indian/Alaskan Students
    - % of Asian Students
    - % of African-American Students
    - % of Hispanic Students
- SES (% of Students with Free or Reduced Lunches)
- Student Language Characteristics
    - % of ELL Students
    - % of LEP Students
- School Organizational Changes
    - # of Principal changes in the School since beginning of project

    - # of School Coordinator changes since the beginning of the project
- Achievement (Changes in PASS Scores)
- Parental Involvement (% mentioned in site interviews)
- Measurements of Program Fidelity
    - STC Log Average
    - Science Inquiry Observation Average

From these profiles, additional analyses were conducted. Data were transformed or standardized, so that they could be rationally filtered, sorted, and compared. For example, Partnership for the Assessment of Standards-Based Science (PASS) scores were translated into z-score gains, while qualitative data were coded into a quantitative measurement (e.g., percentage of site interviews that mentioned parental involvement), and high/low boundaries were determined by +/- standard deviations from the mean from measurements. These indicators were further filtered and sorted to identify potential sites to be included in the case study. Selection of sites could be driven by anomalies in the measurements (e.g., low fidelity, but high achievement), as well as schools with highly diverse student population/communities – with such a low number of cases to examine, sites needed to be selected so that they contained as much contextual diversity as possible, and were able to allow the examination of the LASER i3 intervention in different contexts (Stake, 1994; Stake, 2006). Sites were also considered because of known, unique aspects of a school's learning environment (e.g., Montessori-type approach). Figure 5 shows the basic process for site selection.

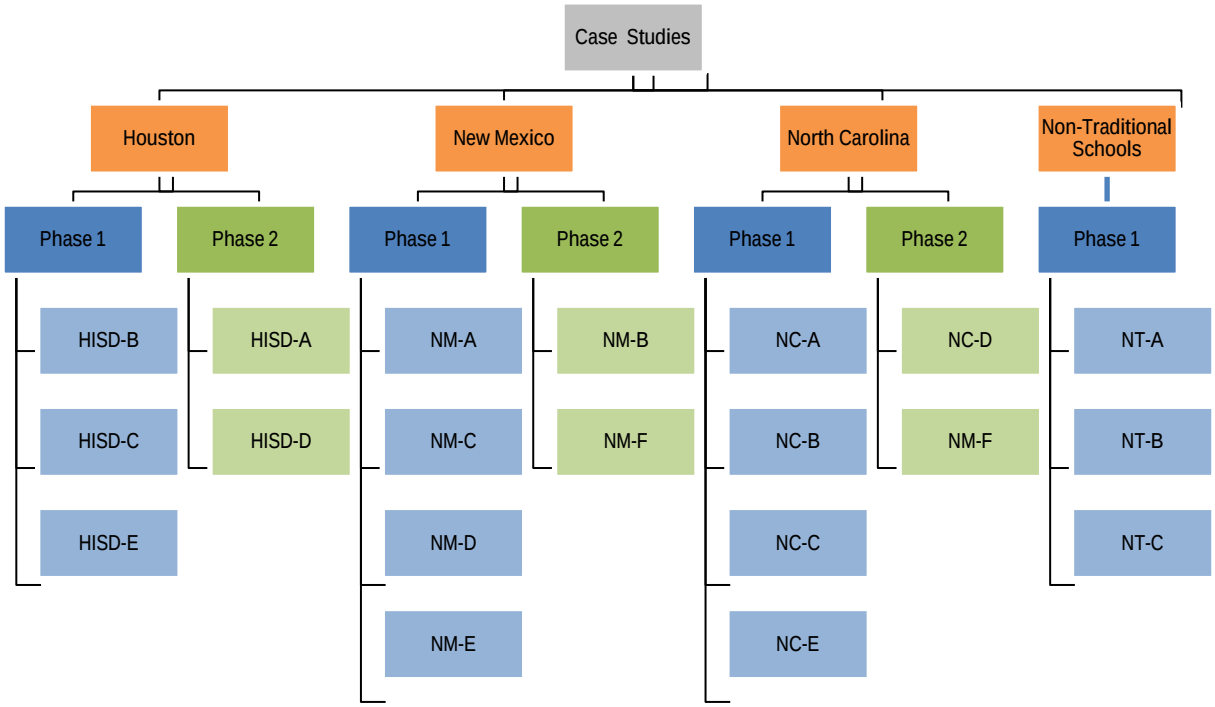
Figure 5: Selection of Case Studies, Based on Site Indicators



Stake (2006) advises that the number of sites selected for a multi-case study should be between four and fifteen. Four to six schools from each of the three regions were targeted for case study analysis. Once a list of schools was finalized for each region, each school was asked to be a part of case studies; however, participation was voluntary. In most cases, schools agreed to participate, though, a few schools declined.

The final number of Phase 1 schools was 14. For the second year, an additional six Phase 2 schools were selected (approximately two from each region were considered), which represented another multi-case study of Non-LASER (control) schools. See Figure 6 for a list of case study schools. In order to protect the anonymity of interviewed school personnel, schools were referenced by pseudonyms (e.g., "Case Study A") and in a random order.

Figure 6: Case Study Schools



Three Phase 1 schools from the three regions were categorized as "non-traditional" because there was at least one distinct educational approach that the schools adopted prior to LASER i3. While these schools' approaches/programs differed from one another, they shared similarities with a hands-on, inquiry-based approach being implemented through the LASER i3 program. To protect anonymity, the schools were not associated with their region in the reports. Had a school been included with its region, details about the specific non-traditional approach/program could not have been written in any detail without compromising the school's anonymity.

Protocol Development

Interview protocols were developed in Fall 2012, prior to the first site visits. See Appendix E. Although there were many questions/prompts, the questions could generally be grouped under the following three themes:

- Background and characteristics of the school (economic, social-political, student achievement), its student population, and community;
- The teaching of science at the school/district, as well as the support structure for teaching (e.g., professional development, materials);
- The future direction/sustainability for teaching science.

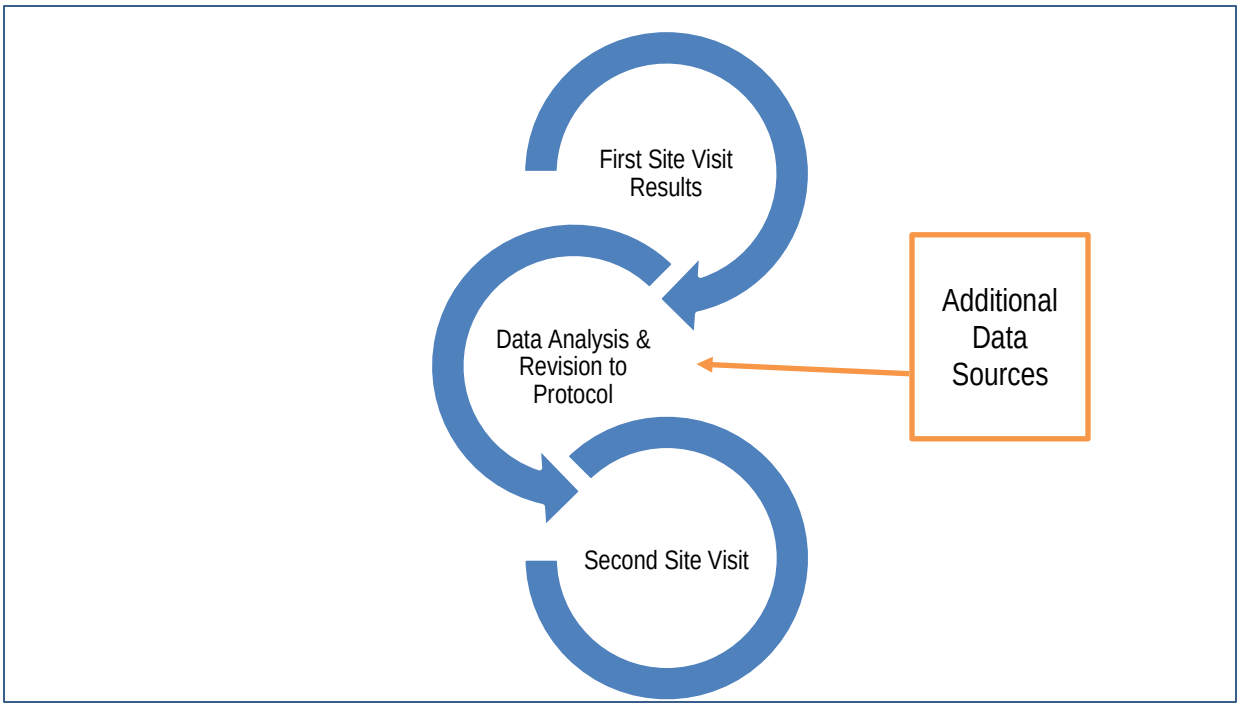
Interview questions/prompts could be modified to align with different participants – school principals, LASER i3 site coordinators, and teachers. Moreover, some questions were also reviewed to align with one or more of the original tracks from the LASER i3 model (Smithsonian Science Education Center, 2013):

- Reforming and promoting student learning in science;
- Addressing the needs of diverse and at-risk student groups;
- Supporting family and community involvement;
- Reforming science teacher professional development;
- Building effective learning networks in science education;
- Promoting and maintaining efficient communication pathways.

Analysis and Refinement of Protocol

Once data were collected from the first set of visits, a general thematic analysis of the findings was conducted and new findings from other data sources (PASS, STC Unit logs, SOM-Sci) were considered. The Year 2 protocol was updated based on these findings in order to elicit further experiences of participants. The merging of additional data sources helped in discovering additional facts and findings for the case studies (Yin, 2009). See Figure 7 for an illustration of this process.

Figure 7: Protocol Development



Site Visits

Visits and interviews were set up prior to arriving at the school. A visit was generally held for one complete school day and included interviews and informal classroom observations conducted by an interviewer and a note-taker. When available, principals and site coordinators were interviewed individually and teacher focus groups were either held with each grade level or in one focus group with multiple grade levels. With the permission of the participants, interviews and focus groups were taped to ensure accurate documentation.

Data Analysis

Analyses of case study data from Year 1 and 2 were completed to better understand the specific phenomenon (LASER i3) being experienced by each site (Stake, 1994; Stake, 2006). Notes and audio (when available) from both site visit interviews were reviewed and summarized.

In order to best capture the key messages from these conversations, this review was completed by the data analyst just prior to drafting the final reports.

In addition to the case study interviews, additional data from other sources were reviewed and are included in the report when appropriate:

- PASS student assessments;
- Science observation instrument (SOM-Sci), used to record observational data collected by site researchers;
- STC Unit Logs, used to record STC implementation data from science teachers in grades 1-8;
- LASER surveys, used to determine each schools' current status of science instruction (completed by district and school administrators as well as science teachers in grades 1-8);
- Site Researcher interview with principal, site coordinator, and teachers in spring 2012.

The alignment of findings, across major topics of interest, was analyzed for each case study site. In addition, cross-case findings were identified that could be used to build a set of general multi-case outcomes. In other words, site-specific findings were matched with the pre-determined topics or themes, as well as emerging findings that were not identified from the initial data analyses (Stake, 2006). Table 2 provides *an example* of a general framework for this relationship.

Table 2: Example Framework for Multiple Site Findings.

Theme	Findings	NC-A	NC-B	NC-C	NC-D
Time	Time it takes to prepare kits	X		X	X
Moving Forward	Funding (kits, materials, PD/training)	X	X	X	X
Alignment	Kits didn't always align with standards	X	X	X	X
Student reaction	Students enjoyed the kits	X	X	X	X
Impact	State achievement scores have increased		X	X	
PD	Enjoyed the experience	X	X	X	X

Reporting

Case study reports were first written at the school level, then regional level, and finally the overall project level.

Organization

School-level reports, grouped by region, and Regional and Non-Traditional school Summaries (See Appendices A - D) were developed to present the experience of LASER i3, using the following organization:

- Background[1]
- Professional Development and Orientation
- Planning and Preparation
- Implementing LASER i3 in the classroom
- Moving Forward
- Conclusions

[1] Data presented in "Background" section of each school-level report came from: United States Census Bureau (2015); National Center for Education Statistic (n.d.); and City-Data (2015).

The project-level and Regional and Non-Traditional schools "Overall Experience" reports, were written and organized using the Five Pillars from the SSEC support system - a framework that SSEC presents as the core of the LASER Model (Smithsonian Science Education Center, 2015).

- Research-based Curriculum
- Differentiated Professional Development
- Administrative and Community Support
- Materials Support
- Assessment

Case study data addressing the pillars of *Research-based Curriculum* and *Assessment* were combined to avoid overlap and repetition. Each report reflects some key challenges/successes, as well as items to consider for this program and similar interventions. Unless otherwise noted, any findings or assertions made in a report were based on information collected during case study visits.

Project-Level – Overall Experience for Case Study Schools

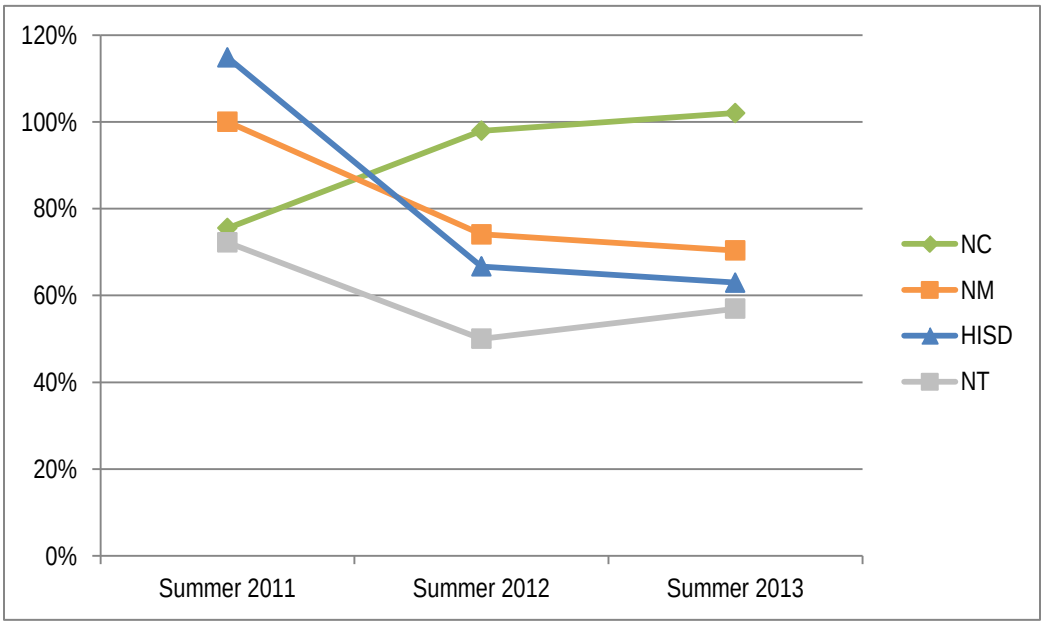
In the context of the SSEC Pillars (Smithsonian Science Education Center, 2015), the following overview considers, at a high level, some key challenges/successes, as well as items to consider for this program and similar interventions.

Differentiated Professional Development (PD)

Many teachers stressed that it was necessary to attend the summer professional development sessions provided by SSEC in order to understand and effectively use the STC units. However, in most cases, teachers did not attend all years of training.

Schools were asked during the first year of LASER i3 to provide the number of science teachers on staff so that attendance percentages could be estimated. As shown in Figure 8, attendance was generally higher the first year in all but North Carolina schools, where the percentage of teachers attending PD sessions actually increased in years two and three. Since the percentages reported here are based on the number of science teachers provided by schools during the 2010-2011 school year, these should be viewed only as general trend data. Attendance greater than 100% may reflect PD attendance of non-science teachers, administrators, etc., changes in the numbers of science teachers during the three years, incomplete or incorrect baseline numbers, or a combination of the three.

Figure 8: Percent of teachers who attended PD



Generally, there were issues raised regarding the schedule for professional development sessions which may have affected participation. It was suggested that it might be beneficial if the training schedule had been better coordinated with the district and school leadership to avoid conflicts with required district activities, and that earlier communication of dates to teachers would have been helpful. Some teachers simply did not want to attend training in the summer. Also, if they were not clear if the training was mandatory, teachers might have chosen not to attend. In some regions, distance to the training site was discussed as prohibitive.

As might be expected, variations in teacher responses to the PD sessions were often related to experience. Teachers with background knowledge in science thought that the PD might not be imperative, and they suggested less emphasis on the science content and more towards using the materials. However, teachers with little science background found the in-depth content knowledge beneficial. Also, because teaching assistants often worked with teachers in setting up and teaching the lessons, it was suggested that they have the opportunity to attend the PD sessions.

Some teachers who attended the first session, did not believe that a review of the material in the following years was necessary. Furthermore, some participants thought that the training sessions might be too long and suggested that more condensed training be offered as an alternative (Note: While Condensed Kit sessions offered by SSEC in years 2 and 3 were designed to address this issue, many teachers were unaware these sessions were offered.) For teachers who could not attend the summer session, other supplementary training was suggested, including online materials (e.g. videos, sample lessons).

Overall, most participants felt positively about the content of the professional development, and they believed that the lessons/units were presented in a well-paced manner. The sessions helped teachers understand the inquiry-based approach and curriculum and prepared them for implementation in the classroom. Additionally, they helped teachers understand the hands-on approach to teaching science, as well as provided the opportunity to practice using the kits. An added benefit of the training sessions was that they provided teachers the opportunity to network to share experiences and lessons learned about implementing the LASER i3 curriculum.

Materials Support

Generally, teachers described the STC kit materials as well-written and well-organized. Units usually contained all that teachers needed for preparing and teaching science lessons. Beyond one site coordinator's concern about the durability of the materials, there was some concern about obtaining the "needed but not supplied" materials (e.g., sand, soil, bottles, Bunsen burners). In some instances, SSEC provided the school with those materials. A handful of teachers felt they did not have the time to find these resources and a few rural schools were not located near a store for purchasing them.

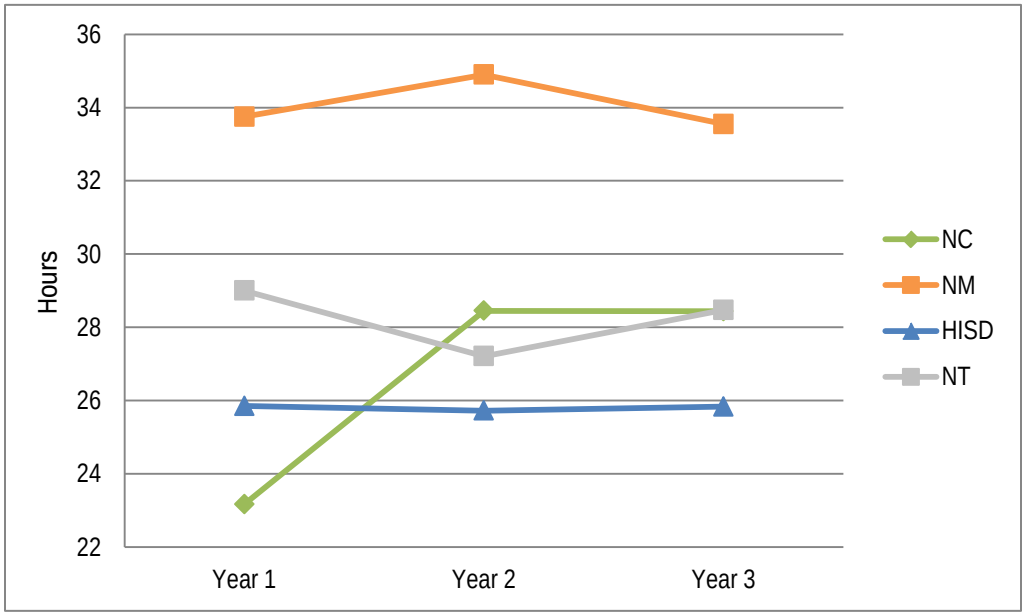
Generally, however, there were sufficient materials. The rate that materials were supplied varied with the region or school. One region reported that additional materials were easily provided through their regional coordinator. However, there were cases where the distribution of supplies might be out of balance (i.e., an over-supply at one school; shortage at another school). This situation could be due to unexpected usage of materials, and monitoring of supplies might not have been well-communicated. For instance, not all teachers were aware that materials were to be shared in a group setting, and some thought each student should have his/her own supplies.

Furthermore, the overall management of supplies could be time-consuming. Beyond the occasional use of a dedicated lab, many classrooms did not have the capacity for storing containers and materials; some schools were challenged in finding a centralized place for storing materials, and in some cases, a centralized location was provided within the district.

Research-Based Curriculum & Assessment

Starting with preparation, planning, and setup, available time was a common issue for many schools. Lessons often took longer than expected and/or for the amount of time, allocated for science instruction, which could limit the time for in-depth coverage of the unit. Teachers sometimes extended lessons beyond a day or skipped an entire lesson. Using teachers' STC unit logs as a source, Figure 9 shows the average number of hours-per-unit that teachers at case study schools reported across the three years of the project. All except New Mexico shows the averages grouped under 30 hours, while New Mexico generally spent more time on units, with an overall average of about 34 hours.

Figure 9: Average Hours Per Unit Reported



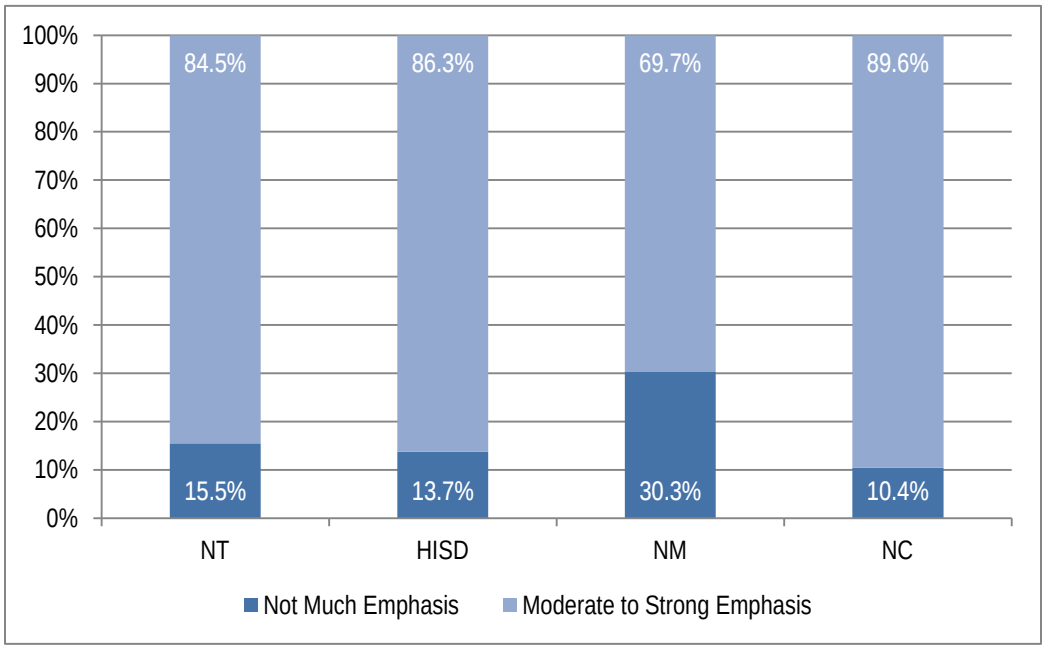
Because there were dedicated time and resources for science, higher grades (i.e., middle school) had fewer issues with available time. However, for the first-through-third grade, time for science had to compete with other needs (e.g., literacy and math), and, particularly with non-traditional schools, other initiatives.

Schools also had concerns about the alignment of LASER i3 with state standards and assessments. If time and resources were issues, the priority often would be toward teaching the standards and getting students ready for the end-of-year assessments. Also, often, teachers did not feel a unit aligned with the grade level. However, within the non-traditional schools, the LASER i3 curriculum seemed to pair well with these school's existing approaches, which already had elements of inquiry-based, hands-on learning. At least one of the non-traditional schools believed that LASER i3 might have improved their state assessment scores.

Although time for science might not have been the highest priority, some schools worked to integrate science with reading and writing. In at least one region growth in student's writing was specifically mentioned. The science journals reportedly supported organizational as well as

general writing skills for students. In reviewing unit logs for the emphasis on student journaling/notebooking over the course of the project, Figure 10 shows that all but New Mexico had "Moderate to Strong Emphasis" ratings of over 80%.

Figure 10: Emphasis on Student Notebooks

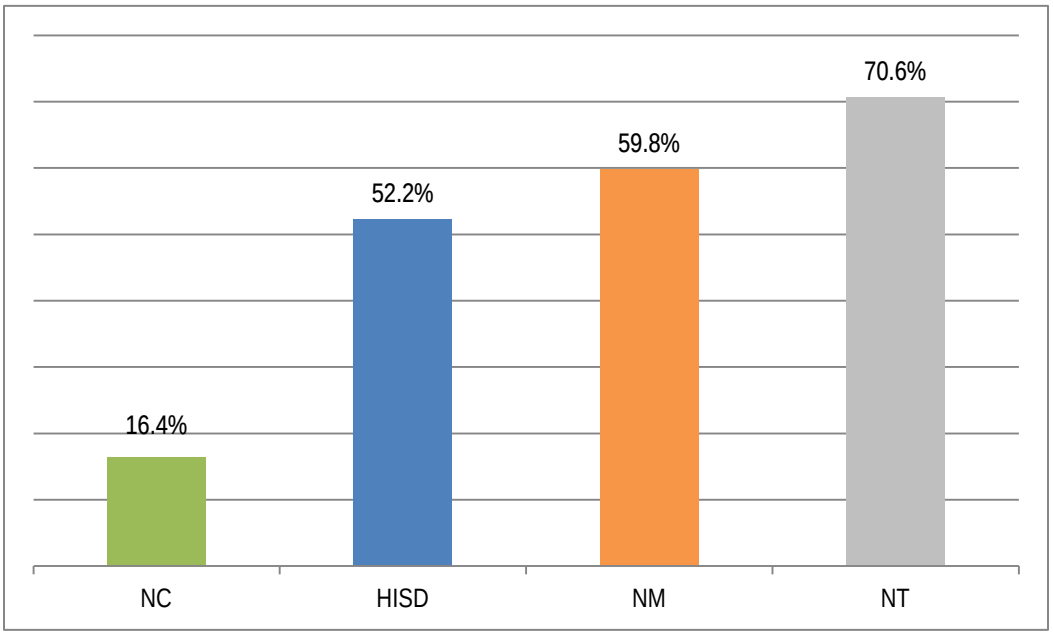


It was common for teachers to mention how much their students enjoyed the science lessons and that they seemed more engaged in learning science. In particular, students liked the hands-on approach to learning science more than reading from a textbook. Some teachers, too, learned the value of using the hands-on approach. However, for the lessons to be effective, it was stressed that teachers needed to believe in the value of inquiry-based learning.

Students also seemed to enjoy group work, and it was reported that group work might have helped at-risk students become more engaged in science lessons. It was common for teachers to mention that, generally, they experienced some success with LASER i3 for at-risk, bilingual, and/or ESL students. However, some of these students still had challenges with reading, and in particular, lower-grade bilingual students often had challenges with vocabulary. It was suggested that, for bilingual students, some Spanish materials might be included with

lesson to help students' transition to English. Using Native American and Hispanic populations as an indicator, Figure 11 shows that all but North Carolina had a potential ESL student population of over 50%. As such, language issues might be expected from schools with a higher percent of bilingual students.

Figure 11: Percent of Possible ESL Students



*Based on 2012-2013 CCD enrollment by ethnicity (Amer Indian/Alaskan + Hispanic)

Generally, it was important that the content and exercises were age/grade appropriate. In some cases, teachers were concerned that the content and activities (such as tying string) were too advanced for their students, and specifically, reading/journaling might be a challenge.

Because of time, alignment with standards/other subjects, or challenges for specific students, some teachers modified lessons. To better monitor progress, some teachers also suggested that assessments need to be more frequent - i.e., after each lesson, instead of at just the end of the unit. It was also suggested that more technology be integrated within the lessons (e.g., on-line resources).

Administrative and Community Support

Generally, there seemed to be limited parental support. In at least one region, the local culture's perception about education seemed to impact the community's support of the school. Language could also be a barrier toward parental support; specifically, if English were not the primary language spoken at home, there might be less parental involvement in helping with homework that was written only in English. It was suggested that some materials might be provided in the parents' language, which might also be helpful for ESL students' transition to English.

School support seemed to be affected by communication. There were concerns that plans for LASER i3 had not been effectively communicated by the district and/or the Smithsonian, most were uncertain about whom would provide the updates to the school. Moving forward, it was suggested that the school district provide ongoing direction, communications, and support for a program – otherwise, it might be perceived by the principals and teachers that the program was not important. One suggestion was that a district consultant position might be established to organize and focus attention toward the program. Funding, too, was assumed to be dependent on the district, and at some schools, third-party partners were being considered.

Along with the district, it was clear that principal support was required, too. Indeed, changes in leadership could impact that support. The site coordinator, too, needed to be a leader who was organized and focused. In short, there needed to be clear/consistent communication from the Smithsonian through the district and school leadership, as well as a site coordinator who was engaged in the implementation of the program to maintain successful implementation.

HISD – Overall Experience for Case Study Schools

Regional Background

All three Phase 1 case study sites were elementary schools (PK-5) from the Houston Independent School District (HISD) in Texas, the largest school district in the state and the seventh-largest in the country. The case study schools' student populations ranged from approximately 450 to 660, and similar to the district, the predominant ethnicities at these three schools were Hispanic (45-65%) and African American (34-49%). Eligibility for free and reduced-price lunch ranged from about 89% to 95%, and all three schools were classified as Title I Schools. Two of the three schools were in the Apollo 20 program - an initiative to improve academic achievement for low-performing schools.

Prior to their participation in the LASER i3 grant, preparation for state testing was the stated or implied focus, particularly for the fifth grade. All three schools had adopted multiple initiatives/programs to boost student performance and achievement scores. Both Apollo schools appeared to be more focused on reading and less focused on science. Furthermore, all schools in HISD were given scope and sequence guides for each subject, which provided teachers with an outline of standards and a suggested order for teaching those standards. Two principals explained how accountability pressures to do well on state assessments made it difficult for teachers and administrators to embrace a new curriculum.

Selection for Case Studies

The three schools were selected as case study sites for several reasons – generally, for the diverse and at-risk student populations (e.g., special education students, Hispanic students, bilingual or English language learners, and students receiving free or reduced-price lunch). Two

schools were also considered because of their performance – high and low – on the PASS assessment, relative to other Phase 1 schools in the project.

Findings Organized by SSEC's Pillars

In the context of the Pillars (Smithsonian Science Education Center, 2015), the following overview considers, at a high-level, some key challenges/successes, as well as items to consider for this program and similar interventions. A more detailed summary of the findings for HISD is in the introduction for Appendix A.

Differentiated Professional Development (PD)

Overall, the LASER i3 program was being implemented, to some degree, by each of the case study schools. Attendance for the PD was strongest during the first summer (2011). In order to improve attendance, school staff recommended that training providers work with individual schools and district to schedule training sessions, add on-line training modules, and increase the availability of condensed kit training sessions.

Those who attended the PD thought that the SSEC professional development sessions allowed them to collaborate with other teachers and provided them deeper content knowledge. They felt the sessions were effective in helping teachers use the inquiry-based approach, as well as prepare them for teaching with the STC units; not receiving the training would result in difficulty with using the materials. It was suggested that including some training in how to successfully align units with state standards and assessments would be helpful.

Materials Support

Teachers appreciated having lessons and materials for science. They were positive about how well-written and organized the STC lessons and teachers' manuals were. There were comments from one school about excessive amounts of materials and containers, while another

school did not believe that they received enough refurbishments for all of the units. The school with a materials surplus may have had teachers who were not using the units. However, in cases where additional materials were needed, the site coordinators usually found it easy to receive those materials through the regional coordinator.

Research-based Curriculum & Assessment

As one principal reported, there was usually not enough time to cover the material in-depth. Teachers also stated that there was not enough time to complete all of the lessons and setup was time-consuming. Teachers were mostly self-contained (i.e., teaching every subject to their students). One school reported that, if they were able to departmentalize science teachers, they might have had more time to prepare and use the units, as well as "dive deeper" into each lesson.

In addition, many of the STC lessons took longer than the time a teacher had allocated for science, and teachers did not believe that the units always aligned well with state standards. As a result, some teachers skipped lessons within a unit or chose to skip the entire unit.

Because the schools were at an elementary level and many of the students at these case study schools were under-performing, much of teachers' time was focused on other core subjects like reading and reading programs to help struggling students (i.e. THINK Literacy and Read 180). Furthermore, a few teachers indicated that the reading and journaling components of the STC units required a level of literacy that was challenging for students to meet, especially if they were not reading at grade level. Some also believed that the writing level required of first graders was developmentally inappropriate for them, as they typically needed assistance.

Despite these difficulties, principals and teachers provided positive observations of how math and writing skills were embedded in the STC units. The school staff reported witnessing growth in students' writing levels, particularly in the fourth and fifth grades.

Moreover, all of the interviewed staff thought that the students enjoyed working with the STC materials, becoming more engaged in science. In particular, teachers described their levels of success in using the STC Curriculum with students identified as at-risk, bilingual, or learning English as a second language (ESL). However, teachers felt the STC lessons would take longer because of challenges that they faced with their at-risk or ESL students, such as limited vocabulary, reading below grade level, and a lack of critical thinking skills.

Administrative and Community Support

Overall, regional material refurbishment and continued professional development, following the LASER i3 grant period, both appeared to be largely dependent upon the district's expectations and decisions regarding curriculum. It was suggested that the district assign a consultant or coach to sustain LASER i3 and provide additional support, show teachers how to reinforce reading and math with the units, and embed inquiry-based instruction into all subjects.

For all of the schools, the use of LASER i3 seemed to depend on the support of the principal, as well as the motivation level of the site coordinator. Teachers were more likely to integrate STC curriculum into the classroom if both of them believed strongly in the inquiry-based approach, and the site coordinator was able to organize, distribute, and educate the teachers about the units.

New Mexico – Overall Experience for Case Study Schools

Regional Background

Four Phase 1 schools were selected for case studies; located in rural areas of central, northern New Mexico. Two of the schools were at the elementary level, while the other two were middle schools. Because New Mexico has a large percentage of Native American and Hispanic families, schools served a large bilingual population, with many students learning English as a second language (ESL). While the four case study schools shared similarities, one school was part of a more affluent community and the other three schools were located in low socioeconomic areas.

Student mobility was reported as low at all four schools. However, district and school-level administration turnover was reported as high within and between districts. Prior to LASER i3 science was typically taught with a science textbook, and students experienced little hands-on learning.

Selection for Case Studies

The four schools were selected for several reasons. Most schools were selected because they had a high proportion of American Indian and/or Hispanic students, English language learners, and students receiving free or reduced-price lunch. One school was also considered because of its high percentage of Asian students, as well as a high average percent correct for the Fall 2011 PASS assessment, relative to other Phase 1 schools in the project.

Findings Organized by SSEC's Pillars

In the context of the Pillars (Smithsonian Science Education Center, 2015), the following overview considers, at a high-level, some key challenges/successes, as well as things to consider

for this program and similar interventions. A more detailed summary of the findings for New Mexico is in the introduction for Appendix B.

Differentiated Professional Development

New Mexico case study schools provided mixed reviews about the LASER i3 program and schools varied in their progress in implementing the units. Although all schools participated in the Smithsonian summer professional development (PD) during the first year (Summer 2011), two of the schools had fewer teachers attend each of the following years, while one school had no attendance for the summer 2013 PD session. (Note that because of distance issues in New Mexico, multiple site-based sessions were held in 2013. Attendance figures for those sessions were not accessed and may include teachers from case study schools.)

Teachers found the PD beneficial in showing them how to implement the units, what to expect, and some of the challenges that they might encounter. Participants noted that practicing the lessons and experiments provided "excellent" preparation for classroom implementation. Teachers felt that not attending the PD would lead to difficulty in using the STC materials.

Teachers had a few suggestions for future PD sessions: better scheduling; communicating with teachers earlier in the year about the PD; more convenient travel distance to training site; offer college credit for PD; and, ensure teachers receive correct training.

Materials Support

Generally, teachers felt the units provided most of the materials needed to instruct entire science lessons, from start-to-finish (i.e. teachers' manuals; lesson plans; high-level questions; materials for the experiments; reading passages; science journals), with the exception of the "needed, but not supplied" items, which were difficult for some teachers to purchase due to the school's proximity to a store. Missing teachers' guides were mentioned as an issue by site

coordinators or teachers who experienced delays in receiving replacements through the SSEC. One teacher chose not to teach from a particular unit until she received the manual.

Research-Based Curriculum & Assessment

Teachers at all schools enjoyed the hands-on manipulatives, the organisms, and how user-friendly the units were, as well as how most materials were provided. However, they thought that the STC lessons required extensive preparation and took longer than the time allocated for science. Moreover, they were concerned that the STC curriculum would not always align well with new initiatives; these schools were adopting new standards (Common Core) and an assessment (PARCC) in the 2014-2015 school year.

Some teachers modified the lessons to fit their needs. Because many students had low knowledge/experience in science, the depth and complexity of concepts discussed in the STC lessons were stated to be too advanced for them.

Still, principals and teachers generally indicated "real excitement" among students when using the materials; saying that they "absolutely love it" and were "totally engaged," "really enthusiastic," and "really having fun." Most teachers indicated that students were getting more from their engagement with the inquiry process, as well as working with the hands-on materials, than they had from a textbook. However, middle school teachers felt many of their "at-risk" or ESL students struggled with the STC curriculum either because it was different and overwhelming or because of the language barrier.

Administrative and Community Support

Most schools were unsure of their future with the LASER i3 grant. It was stated that plans had not been effectively communicated by the district or Smithsonian to the staff. One teacher claimed the lack of communication caused him to think LASER i3 was not important.

Refurbishment of future materials and provision of professional development appeared to be district-dependent, and decisions were district-specific within this region. Three schools mentioned possible support from Los Alamos National Lab (LANL). They were hopeful that, because LASER i3 was a science grant and LANL was a science laboratory, funds would be easy to secure for future STC refurbishments and/or professional development.

A few schools felt that they lacked community and parental support because of cultural differences. For example, the practice of questioning a teacher, as part of an inquiry-based science program, appeared to be in opposition to beliefs in the Native American culture. A pueblo community's perceived lack of need for education also appeared to contribute to the absence of community/parental involvement and motivation. Still, many of the parents were involved if their child was in a play or sports activity. However, interaction with parents in curricular decisions tended to be more limited, possibly due to lengthy commuting distances.

North Carolina – Overall Experience for Case Study Schools

Regional Background

Though primarily rural, the four North Carolina Phase 1 case study schools were from diverse communities across the state of North Carolina. The local community populations ranged from 290 to 20,000 residents. The median annual household incomes were as low as $18K and as high as $57K, while the poverty rate ranged from about 27% to 45%.

Of the four schools, three were elementary level and one was a middle school. The schools' student populations ranged from approximately 280 to 425 students and the predominant ethnicity was Caucasian (57-91%). Qualifications for free and reduced-priced lunch ranged from about 33% to 80% and all four schools were classified as Title I Schools. Three of the schools were located among lower socioeconomic communities, while one school was part of a more affluent community.

Prior to LASER i3 the schools had either out-of-date or no science textbooks, but schools were provided science kits by their respective districts. Teachers reported that if they had participated in professional development for science, it had been many years earlier. Reading and mathematics were the primary focus of most of the schools, especially at the elementary level, as these subjects are considered the "building blocks" for most elementary students' educations. In the summer of 2010, North Carolina adopted the Common Core standards which placed a focus on K-12 English Language, Arts, and Mathematics. Schools were expected to fully implement these new standards by 2012-2013. Another initiative, "Read-to-Achieve," was adopted by North Carolina in July 2012 and applied to all elementary schools in the 2013-2014 school year. Although "Read-to-Achieve" was specifically targeted

toward the third-grade, it seemed to have an impact on the first, second, and forth grades as well.

Selection for Case Studies

The four schools were selected for case studies for several reasons. Primarily, schools were targeted for including higher occurrences of inquiry-based science classes in the earlier part of the project, as well achieving high gains on performance for the students' PASS scores relative to other Phase 1 schools in the project. One school was also considered because of its high percentage of students qualifying for free and reduced-price lunch.

Findings Organized by SSEC's Pillars

In the context of the Pillars (Smithsonian Science Education Center, 2015), the following overview considers, at a high level, some key challenges and successes, as well as information to consider for this program and similar interventions. A more detailed summary of the findings for North Carolina is in the introduction for Appendix C.

Differentiated Professional Development

Overall, the LASER i3 program was well received by much of the staff at the North Carolina case study schools. Teachers who attended the SSEC professional development (PD) sessions said they gained in-depth content knowledge, hands-on experience, and ideas for how to pace each lesson and unit, which they felt prepared them to use the inquiry-based approach and STC units in a classroom setting. The PD also provided teachers with an opportunity for networking, which later enabled teachers to learn how others used units in their classrooms.

Some teachers chose not to attend the PD sessions; often, because the sessions were offered at the beginning of their summer breaks, or because attendance was not perceived as mandatory. Those teachers who did not attend the PD found, in most cases, the STC units

difficult to understand and apply. Also, some of the teachers who attended the first-year PD (summer 2011) did not think it was necessary to participate the following year, and instead, chose to read the teacher's manual to prepare for the next year 's units.

Often, feedback varied depending on the teachers being interviewed. Teachers with a strong background in science, for example, reportedly did not think it was necessary to be part of the PD sessions that were dedicated to content knowledge (i.e., Level 2). Other teachers thought that some of the content knowledge was presented at too high of a level to take back and apply in the classroom.

There were also some concerns about the PD schedule. Many teachers felt a week of PD was too long and suggested a shorter session that placed less emphasis on content and more focus on the preparation and teaching of units. Also, some teachers who attended a previous PD did not find it beneficial to review the PD the following year.

Materials Support

Generally, teachers felt the STC units provided most of the materials needed to instruct an entire lesson from start-to-finish (i.e. teacher's manual, lesson plans, high-level questions, materials for the experiment, reading passages, and science journals), with the exception of the "needed, but not supplied" items (e.g., bags of sand, soil or gravel, Bunsen burners). If any additional materials were needed, the site coordinators or teachers usually found it easy to get those materials through the regional coordinator.

Research-Based Curriculum & Assessment

A major planning and preparation issue was with the alignment of the units with ever-changing standards and curricula, such as with Common Core and other initiatives. Having to

refocus toward state-mandated programs could leave teachers with less time and energy for science instruction and LASER i3.

Also, STC units took a good deal of time to properly implement. Specifically, adequate time was an issue for planning, preparation, and implementation of the units in classrooms. One way that teachers attempted to address this issue was to extend lessons over more than one day or skip certain lessons. However, teachers from higher grades appeared to have fewer time concerns. Particularly for middle-schools, there might be dedicated science teachers, as well as dedicated space for to conduct experiments (i.e. labs), as well as the time to prepare the room for an experiment.

Teachers appreciated the reading passages provided in the STC units, which could help with integrating science with reading and specifically addressed the demands from the Read-to-Achieve initiative. The use of science journals also helped address the demands from Read-to-Achieve. The majority of teachers thought that the journals were a good part of the units, and valued the integration of science with writing.

Furthermore, most students, including those identified as at-risk or EC (Exceptional Children) became more engaged in science and benefitted from the hands-on inquiry-based lessons. By working with the hands-on, inquiry based approach, EC students seem to better understand scientific concepts, and they also seemed to learn from other students by working in groups.

Administrative and Community Support

Overall, most of the case study schools seemed interested in using the STC units after LASER i3, and particularly when there were improvements in science scores. However, most school staff appeared to feel as if they were on their own, possibly because the intent to continue

LASER i3 (i.e. funding; material refurbishment; PD) and the overall plan for science instruction in the district had not been communicated to them. Also, school staff were concerned regarding changes in leadership (e.g., new principal or district administrator), which could shift the focus away from the LASER i3 program or related science instruction.

Non-Traditional – Overall Experience for Case Study Schools

Regional Background

Three Phase 1 schools had unique educational approaches, which differed, in notable ways from traditional schools in the three regions. While each school used a different approach or model, they all were philosophically compatible with the inquiry-based approach used in the LASER i3 program. Because of this distinction, these schools were more like each other than they were like the other case study schools in their respective regions and would have been easily identifiable within each regional report. Thus, they have been grouped together for discussion and regional backgrounds or regional identifiers are excluded from this section of the report.

All three schools were Title I schools with a range from 57-95% of students receiving free or reduced-price lunch. The dominant ethnicity was Hispanic (53-95%) with White being the second most predominant ethnicity in two of the schools (21-25%) and African American the second most predominant race at one school (3%). All three schools had about 600 students; however, each school served different grade levels.

Selection for Case Studies

Besides their unique educational approaches, the three schools were selected as case study sites because they had diverse, and a somewhat large, at-risk student populations (e.g., Hispanic, English language learners, and students receiving free or reduced-price lunch). In addition, one school was considered because of its positive performance for all three areas of the PASS assessment, relative to other Phase 1 schools in the project.

Findings Organized by SSEC's Pillars

In the context of the Pillars (Smithsonian Science Education Center, 2015), the following overview considers, at a high level, some key challenges/successes, as well as items to consider for this program and similar interventions. A more detailed summary of the findings for non-traditional schools is in the introduction for Appendix D.

Differentiated Professional Development (PD)

Overall, teachers thought the PD sessions were beneficial and well-organized. The sessions prepared teachers for using the units in the classroom and deepened many teachers' content knowledge (Level 2). Also, the PD appeared to help teachers who found the curriculum difficult. It was reportedly important to attend the PD; not receiving the training resulted in difficulty with using the kits. It was suggested that other staff (i.e., teaching assistants) be allowed to participate in PD, because they, too, worked closely with students.

In order to improve participation, it was suggested that training sessions be announced well in advance. If a teacher was not be able to attend, it was suggested that supplementary training (e.g., training videos; sample notebooks) be offered, which could be reviewed throughout the school year and could also help in keeping teachers motivated and on track.

Materials Support

STC units provided a teacher with sufficient materials for teaching a well-organized science lesson. However, managing and storing materials could be difficult and time-consuming, especially for a new site coordinator. Also, schools might not have the capacity to store the containers in a centralized location, and teachers were not always able to store them in their classrooms. One site coordinator showed concern in regard to the durability of the

materials, which could confound the ability to share materials, as well as reuse them for the following year.

Research-based Curriculum & Assessment

Overall, the interviewed staff were positive about the units, and generally, everyone thought the LASER i3 program paired-well with the inquiry-based program that the schools were already using. Furthermore, most teachers felt integrating other subjects with the STC lessons was possible (e.g., reading, writing, and math). However, having technology incorporated into the kits was suggested (e.g., PowerPoint presentations, video clips, websites, and/or on-line lesson plans).

Students enjoyed working with the hands-on inquiry-based materials. The STC lessons had students engaged, involved, interested, and experiencing hands-on learning during science. Students also seemed excited to work in groups. Furthermore, one site coordinator believed that the students' state assessments scores for science were the highest because of the inquiry-based approach being used, and, moreover, the STC units better prepared students for the state assessment by developing expository reading.

Students were becoming better writers and learning about organization through using science journals; the notebooks added efficacy to the STC lesson and embedded writing within science. Students, including bilingual students, were using science vocabulary and staying motivated and on-task during science. However, a first grade teacher thought the level of writing and knowledge of vocabulary was too high for her students. Also, lower elementary students – particularly those still receiving some daily instruction in Spanish - struggled with reading everything in English.

Available time was one of the biggest challenges for all three schools. Teaching STC lessons took longer than anticipated. Also, units were lengthy, and some teachers chose to shorten lessons in order to finish on time, or to not teach a lesson as in-depth. One teacher chose to skip entire lessons that did not align with the curriculum. Teachers were also concerned about spreading their time across other initiatives. Ensuring that the units aligned with the grade-level curriculum would be beneficial to further secure future teacher acceptance.

In regard to assessment, it was suggested that building in more intermittent formative assessments within the STC units, instead of one assessment at the end, would be helpful for teachers in assessing learning throughout the unit. Also, giving teachers the option of dropping the last few lessons of each unit, which seemed to be more specialized, might be beneficial for teachers who were dealing with time constraints and preparing students for end-of-year assessments.

Administrative and Community Support

If school leadership (i.e., principal) were supportive of the LASER i3 program, funding seemed more likely to be available for continued PD and material refurbishment. District level buy-in seemed to also be important.

Language barriers could have been an issue for the bilingual population, which could affect parental support. To better involve Spanish-speaking parents with homework, it was suggested that some of the STC materials be provided in Spanish.

Limitations and Other Considerations

Again, part of selecting the schools for case studies was to select enough diversity (i.e., student population, measurement results) for providing a richer narrative about the experience of implementing LASER i3. However, there is the question of how representative these case study schools are compared with all treatment schools. For example, the home lives of the students--including parenting styles, level of household stress, sibling relationships, neighborhood characteristics, and so on—would be expected to affect their engagement in the classroom. Bronfenbrenner (1977) emphasized a theory of human development in which the individual's entire ecological context, from immediate face-to-face interactions to wider, cultural influences, must be considered when examining any aspect of behavior. This model includes several layers of environmental influences, envisioned by a set of concentric circles that represent near-to-more remote contexts that affect and are affected by the individual (e.g., from the home environment, to the local community, and out to the wider society).

Also, it should be emphasized that most of the information reported for case studies was gathered, primarily through three sets of interviews of principals, site coordinators (who were often times teachers) and teachers, which can further limit interpretations. For example, teachers bring their own personal histories and belief systems to a classroom; past research indicates that teachers' classroom behavior differs for high-risk and low-risk students (e.g., Winfield, 1986). Teachers may assume that parents of low educational attainment do not value education for their children when this is not actually the case. Language barriers may influence teachers' expectations for student abilities. Furthermore, the number of visible role models for particular vocations—such as in the field of science—may affect a child's affinity for the subject and view of self in relation to the subject. Because of these multiple layers of influence, some outcomes

indicated by the case studies may appear difficult to explain with the limited information available.

Comparing Effect Size

Although it does not guarantee generalizability for the case studies findings, one method for seeing if the schools were potentially similar with the other phase 1 schools was by comparing some quantitative measurements. One way was by considering the difference in PASS measurements – Multiple-choice (MC), Open-Ended (OE), and Performance-Task (PT) – between all other phase 1 schools in the project/region and the case studies school schools, using *effect size*.

Effect size shows impact or "practical significance" of a particular intervention. It is a descriptive statistic, which quantifies the size of difference (in standard deviation units) between two variables and can be presented with a plus (+) or minus (-) ranging from 0.0 to 3.0. If the effect size is positive (+) that would indicate a higher mean than the comparison group (e.g., the schools from a case study region performed better than other Phase 1 schools in the project). If the effect size is negative (-) that would indicate a lower mean (e.g., the schools from a case study region performed worse than other Phase 1 schools in the project). The larger the effect size number, the greater the difference between the two groups. Based on guidelines from the What Works Clearinghouse – a research arm for the U.S. Department of Education – an effect size of +/- 0.25 is considered to be "substantively important" (What Works Clearinghouse, 2011). Table 3 provides a high-level overview of the differences between the case studies schools versus the regional and project-level averages. Red cells represent if the case study schools had an effect size of -0.25 or greater. Green cells represent if the case study schools had

an effect size of +0.25 or greater. Blank cells represent no substantive important effect size, meaning the number fell between -0.25 and +0.25.

For North Carolina, the case studies schools appeared to be very similar (i.e., less than 0.25 effect size) to the other Phase 1 schools in its region, as well as the project. The two exceptions were that the case study schools performed higher than the other schools in the NC region for the Open-Ended (OE) section of the PASS test in Spring 2012 and lower than the overall schools for the Performance Task (PT) section in Spring 2014.

For New Mexico, the Multiple Choice (MC) scores were similar except in Spring 2014 when the case study schools were lower than all other Phase 1 schools in the project. For PT, the schools were similar, except for Spring 2012, when the schools did better than both other regional schools, as well as the overall project. On the other hand, the New Mexico case study schools were lower than all of the other regional schools on the OE, for all years; moreover, it was also lower than the overall project schools in Spring 2014.

The Houston schools, however, did not appear to be very similar to either the region nor the overall project. Although there were a few cases where the measurements were similar or higher, the general pattern for most measurements was that the school performed lower than both of those populations on all sections of the PASS test.

PASS results for non-traditional schools were not analyzed because data were insufficient (e.g., baseline data were not available for all schools; non-focal schools completed only the Multiple Choice section of the PASS) and because they are located in multiple regions and could not be compared to a specific region. Based on only those simple comparisons, the narratives from North Carolina and New Mexico might provide some limited representation for their

regions and/or the overall project. On the other hand, the schools reported for Houston might not be as representative.

Table 3: High-Level Effect Size Differences

Region	PASS Measurement	Regional 2012	Regional 2013	Regional 2014	Project 2012	Project 2013	Project 2014
North Carolina	MC						
	OE	0.27					
	PT						-0.27
New Mexico	MC						-0.35
	OE	-0.40	-0.41	-0.79			-0.52
	PT	0.31			0.50		
HISD	MC	0.40	-0.31	-0.32	0.28	-0.48	
	OE	-0.78	-0.79	-0.74	-1.58	-1.01	-1.06
	PT		-0.63	-0.89		-0.59	-0.62

High and Low performing case-study schools

As mentioned about the non-traditional schools, and as Table 4 shows, some schools did not have all measurements – particularly, OE and PT – so, there were limitations in analyzing effect sizes. However, in the context of reviewing the effect size analysis, there were a few case study schools that generally had an effect size that was +/- 0.25 for the MC, OE, and/or PT measurements. There were two schools that, over the course of the project, normally performed higher (NT-A and NM-D), while there two other schools (HISD-E and NM-A), normally performed lower.

In comparing the narratives for these two sets of schools, there are some topics that they share in common. The higher performing schools generally serve more affluent families (particularly, NM-D), and parents may have been more engaged in their children's science learning. In contrast, the lower performing schools appeared to be in less affluent areas. Additionally, the ethnicity of student populations in those schools raises the potential issue of cultural/language issues with potential impact on the perceived value of science education. In

contrast, the NM-D community appeared to be very pro-science, while the inquiry-based approach was already a part of NT-A's curriculum. Moreover, because NT-A might have been an optional school, at least for some families, there may have been additional parental engagement.

Students from both the high and low performing schools were reported to enjoy the hands-on approach. However, again, language appeared be an issue in learning science. Interestingly, in reviewing how case study schools compared in state reading assessments (effect size for case study schools versus project schools in the region), the high performing schools did very well in these measurements, too, while the low performing schools did not. Moreover, schools that did well on state reading assessments, tended to do well with the open-ended and performance-task measurements, and vice-versa. Thus, the ability to read seemed to be strongly related to the ability to work through word/written-problems. This finding not only illustrates the importance of language in instructing science, but may also reinforce the use of science journals as part of science instruction.

Table 4: School Level Effect Size Differences

	Fall 2011	Spring 2012				Spring 2013				Spring 2014			
Case	MC	MC	OE	PT	Reading	MC	OE	PT	Reading	MC	OE	PT	Reading
NC-A	-0.37	-0.36	1.07	-0.67	-0.28	-0.17	0.35	-0.28	-0.44	-0.84	0.59	-0.54	-0.22
NC-B	-0.47	-0.08	-0.71	0.18	-0.34	-0.25	-0.31	-0.16	-0.32	0.57	-0.90	-0.20	-0.39
NC-C	0.72	0.76			0.61	0.29			0.66	0.72			0.26
NC-E	-0.23	0.58	-0.01	0.46	-0.34	-0.22	-0.68	-0.12	-0.27	0.42	-0.37	0.02	-0.20
NM-A	-0.90	-0.60	-0.18	-0.33	-0.81	-0.95	-0.59	-0.81	-1.05	-0.77	-1.11	-1.14	-0.94
NM-C	-0.34	-1.02			-0.59	-0.18			-0.52	-1.29			-0.41
NM-D	0.70	0.89	0.01	0.75	0.26	0.62	0.01	0.57	0.32	0.75	-0.31	0.52	0.59
NM-E	0.25	-0.89			-0.06	-0.24			-0.25	-0.60			-0.25
NT-A		0.89			0.99	1.10	0.98	0.81	1.20	-0.03	1.08	1.30	0.94
NT-B	-0.85	-0.41			-0.28	-0.69			-0.38	-0.13			-0.32
NT-C		0.24				-0.01				0.12			
HISD-B	0.84	0.08	-2.30	0.13	-0.03	0.58	-0.20	0.59	0.22	0.95	-0.57	-0.24	0.72
HISD-C	0.22	1.02			-0.29	0.34			-0.21	0.12			-0.25
HISD-E	-1.46	0.05	-1.51	-0.04	-0.29	-1.31	-1.12	-0.96	-0.98	-0.44	-1.13	-0.72	-1.01

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Appendix A: Summary of Findings in HISD Case Study Schools

Regional Background

Three Phase 1 schools were selected for case studies, and all were elementary (PK-5) and part of the Houston Independent School District (HISD), which provides services to the majority of Houston, Texas students. HISD is the largest school district in the state and the seventh-largest in the country. During the case study interviews, the district served approximately 283 schools and 215,000 students. The ethnicities predominate in the district were Hispanic (~62%) and African American (~25%), and approximately 76% of the entire student population were classified as economically disadvantaged. The median household income for the city of Houston was a little less than $43,000, with a poverty rate of about 23.5%.

Similar to the district, HISD case study schools consisted of mostly Hispanic (~55%) and African American (~42%) students. The schools also had a high proportion of English as a Second Language (ESL) students. These three schools were classified as Title I and had a large number of students who qualified for free or reduced-price lunch (~90%). Student mobility was reported as high. Two of the schools were in the Apollo 20 program - an initiative to improve academic achievement for low-performing schools.

Prior to their participation in the LASER i3 grant, particularly for the fifth grade, preparation for state testing was the stated or implied focus. Two principals explained how pressures on accountability made it difficult for both teachers and administrators to embrace a new curriculum. One principal described the difficulty of balancing the need to maintain accountability with the broader need for public education reform. Another principal suggested that “fear for one’s job” had led teachers to focus their instruction on content that was measured by state assessments.

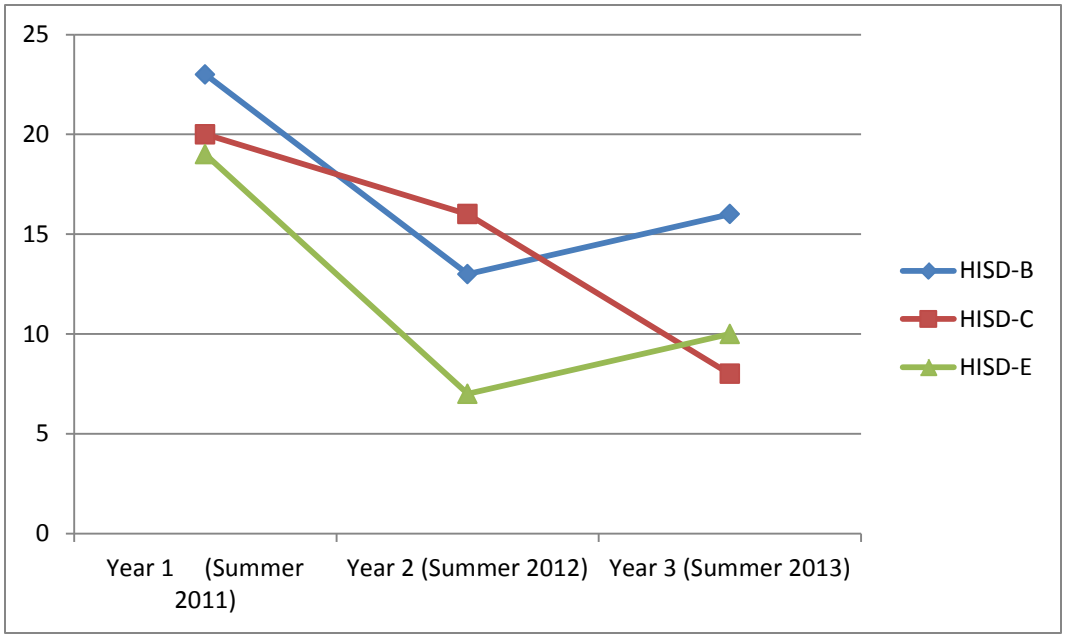
Selection for Case Studies

The three schools were selected as case study sites for several reasons – one being for the diverse and at-risk student populations (i.e., special education, Hispanic, bilingual or English language learners, and students receiving free or reduced-price lunch). Two schools were also considered because of their performance – a combination of high and low results - on the PASS assessment relative to other Phase 1 schools in the project.

Professional Development and Orientation

For all three schools, the greatest attendance by teachers was at the first professional development (PD) session (Summer 2011). After that, the number of attendees declined for all three schools in the second year, but rose for two schools in the third year. See Figure 12.

Figure 12: Professional Development Attendance for HISD Case Study Schools



Those who attended the PD said it was beneficial. It allowed them to collaborate with other teachers, provided deeper content knowledge, and was effective in helping teachers organize and prepare for teaching with the STC units. Teachers thought that not receiving the training would result in difficulty with using the materials.

The staff from the three schools offered four major recommendations for improving the summer training sessions. In the future, PD providers should:

- work with individual schools, as well as with the district, to schedule training sessions and to better accommodate other school-level PD needs,
- add on-line training modules for those teachers who are unable to attend,
- increase the availability of condensed kit training sessions to address mid-year shifts in staffing, as well as sustain year-long instructional support for teachers, and
- provide support that is focused toward helping teachers understand how the units are aligned with state standards and assessment.

Planning and Preparation

Teachers appreciated having lessons and materials for science, and they liked how well-written and organized the STC lessons and teachers' manuals were. However, as one principal explained, there was not enough time to cover the material in-depth. Many of the STC lessons took longer than the time a teacher had allocated for science, and teachers did not believe that the units always aligned well with state standards. As a result, some teachers skipped lessons within a unit or chose to skip an entire unit.

Teachers also stated that there was not enough time to complete all of the lessons and that setup was time-consuming. Teachers were self-contained (i.e., teaching every subject to their students). One school reported that, if they were able to departmentalize science teachers, they might have had more time to prepare and use the units, as well as "dive deeper" into each lesson.

Because the schools were at an elementary level, and moreover, probably because many of the students at these case study schools were under-performing, many teachers focused their

time on other core subjects like reading (i.e. THINK Literacy and Read 180). Furthermore, a few teachers indicated that the reading and journaling components of the STC units required a level of literacy that was challenging for students to meet. They believed that the writing level required of first graders was developmentally inappropriate for them, and they typically needed assistance. Students with low reading levels also struggled with the STC units.

Despite these difficulties, principals and teachers gave positive observations of how math and writing skills were embedded in the STC units. The school staff reported witnessing growth in students' writing levels, particularly in the fourth and fifth grades.

Implementing LASER i3 in the Classroom

Site coordinators confidently stated that using the STC Curriculum would eventually lead to better state assessment scores, reflecting increased learning in science. Teachers and principals indicated high student engagement with the STC materials, particularly with *Solids and Liquids, Land and Water, Butterflies, Electricity, and Forces and Motion*. One site coordinator pointed out that the fifth grade boys, in particular, were engaged while using the STC materials; moreover, they believed that these students' science, reading, and math scores improved. Another site coordinator indicated that academically-challenged students were very interested in the lessons, and learned much more from some of them than they likely would from a book.

Teachers also described their levels of success in using the STC Curriculum with students identified as being at-risk, as well as students who were bilingual or ESL. One teacher indicated that hands-on lessons were more effective for these students with different learning needs because it kept them engaged. Another teacher added that the experiments helped ESL students with their language, as well as improved other skill sets.

However, teaching at-risk and ESL students by using the STC units could also present challenges; students struggled with reading at grade level, had limited vocabulary, and had under-developed critical thinking skills. Also, because a teacher may have had to teach simple vocabulary or read the lesson aloud, the lessons generally took longer to teach. In some instances teachers thought that they needed to modify the lessons for accommodating the students' diverse needs.

There were several suggestions for addressing ESL students. One principal suggested that the younger grades would benefit more if all of the STC units were translated into Spanish. Due to his students' low exposure and knowledge of vocabulary, one teacher indicated that he used ESL strategies (i.e., translation) with all of his classes. Another suggestion for lower grade ESL students was a vocabulary wall - when teaching from each unit, the wall would feature pictures that supplemented the lessons.

Moving Forward

The refurbishment of materials in this region, as well as the continuity of PD after the LASER i3 grant period, both appeared to be largely dependent upon the district's expectations and decisions regarding curriculum. However, a successful implementation of STC units would need to be driven by a supportive and knowledgeable principal and site coordinator. Moreover, it was suggested that the district assign or employ a consultant or coach to sustain LASER i3. This consultant would provide additional support, coach teachers in how to reinforce reading and math with the units, and support the integration of inquiry-based instruction into all subjects.

Both principals and teachers stressed that continued professional development was necessary, particularly for new teachers. Furthermore, without PD, some teachers thought the units would be difficult to use.

It was suggested that the STC curriculum needed to be aligned better with state standards, which might entice teachers to use them more in the future. One school planned to use a more customized approach, where teachers would plan to use certain units at different grade levels, as well as teach a lesson when it best aligned with their pacing guide.

Selection for Case Studies – Summary

In revisiting the reasons for selecting the schools for case studies, particularly after reviewing PASS scores there were mixed results. One school made gains in the multiple choice score for each year, and also showed slight gains in inquiry-based observation scores. Another school showed the same trend with the inquiry-based observation score, but its PASS scores fell in Year 2 and then increased in Year 3. The third school's PASS scores decreased each year, and inquiry-based observations were not conducted there. For at least two of the schools, there appeared to be a consistent practice of using inquiry-based instruction, as well as some increase in scores by the third year.

Again, it should be noted that most schools were chosen because of the diverse student population (at-risk, ESL, free and reduced-price lunch). In cases where lower fidelity and achievement occurred, issues with language/vocabulary, along with other cultural differences, might help explain these results.

Phase 2 Schools Summary

For 2013-2014, two Phase-2 schools were also selected for case studies. Both schools were large (over 600 students); however one was an elementary school, while the other was a middle school. For both schools, the student population was predominately Hispanic and African American. Both were classified as Title I schools, with more than 80% of students receiving free or reduced-price lunch.

A primary reason one school was chosen was because it was a middle school, and the students showed a large gain in PASS multiple choice scores from Spring 2012 to Spring 2013. This school used a *teach-reteach* cycle. It appeared that teachers were thoroughly guided, and watched, to ensure they were following this approach. Generally, in a three week period, students were taught, then tested, then retaught, based on the results of the assessment. The site coordinator mentioned that inquiry-based instruction was used "maybe once or twice a quarter."

The other school was chosen primarily because of the growth in the PASS performance task score (a measurement of inquiry-based science) from Spring 2012 to Spring 2013 and because it had a focus towards environmental science. At this school, most teachers were reported to use hands-on inquiry based instruction through the Independent Investigation Method $(IIM)^2$. Teachers felt they were provided enough science resources and books, and a few teachers were using non-STC kits. The principal thought that the students' achievement scores had increased, since the school had placed an emphasis on science.

[2] Teaching model used in the classroom to teach students an "authentic research process" (http://www.iimresearch.com/).

HISD Case Study B (HISD-B)

For HISD-B, there were challenges gathering information via the interviews, which limited data analysis. Although the principal was available for both years of case study interviews, there was a different site coordinator interviewed each year. Also, teachers were not available for interviews in the first year, but two teachers were available in the second year.

Background

A reason that this school was selected for inclusion in the case studies was because it was comprised of a diverse student population. The school served 661 children, from grades PK – 5. Approximately half were African American (~49%), while the other half were Hispanic (~45%). According to the principal, 40% of the student population was learning English as a second language (ESL) and student mobility was high.

Another reason for selecting the school was because of the large proportion of students receiving free or reduced-price lunch (~89%). The school was a Title I School, and one teacher referred to it as "under-performing."

Every teacher taught science except for 4th grade, where science was departmentalized (i.e. one teacher taught science). Prior to LASER, teachers taught science once or twice a week, utilizing the "hands-on" learning approach about once a week during science lab. Teachers said that textbooks and demonstrations were the primary sources for science instruction; generally, the teacher would demonstrate the experiments while the students observed.

Teachers also said there was a lack of resources for science, and as one teacher commented about the implementation of science instruction in their classrooms, "[They were] basically on their own."

Professional Development and Orientation

The principal said, “The [SSEC] PD opportunities are great. There are quite a few. They are organized.”

The site coordinator (from the 1st year interview) felt the PD was very effective. Also, the training sessions allowed teachers to collaborate with other schools, which helped in gauging the effectiveness of the units. The 2nd year site coordinator noted that teachers who were able to attend the summer PD session provided training to those teachers who did not. The coordinator felt the STC kits were a little difficult to follow for those who did not attend that session.

If a teacher was not feeling comfortable teaching an STC unit, the site coordinator paired them with a more experienced teacher. Several teachers were either new hires or had changed grade levels and therefore, were not trained for the STC unit that they were asked to implement in their classroom.

Generally, the principal recommended “more support for the teachers in order for them to understand the content and how to teach [to the state assessment] with the kits. The deeper content is important.”

Preparation and Planning

During the 2013-2014 interviews, the site coordinator stated that the teachers were using the STC units as they had been asked to use them. A teacher mentioned that the units provided everything (i.e. materials, manuals, vocabulary, readers) needed to teach them. However, this teacher had concerns about covering all the lessons in a unit, while keeping up with the curriculum. Both the site coordinator and this teacher felt that if they kept up with one, either the STC lessons or the curriculum, they would fall behind in the other because they were not fully aligned with one another.

The state standards (Texas Essential Knowledge and Skills, or "TEKS") also seemed to impact implementation of the STC units. For example, one teacher felt the *Forces and Motion* unit, which was to be implemented in the fifth grade, did not align well with the standards and thought it would be better suited for the third grade, when those standards were required. The site coordinator felt aligning the two might lead to more support from the principal and encourage teachers to implement the units with fidelity.

"You can't just go in and say you're going to do a lesson. You have to be totally prepared."

The principal noted how being a part of LASER has helped the district put more emphasis on science, but recommended a technology component, such as a virtual visit to an erosion site, because she believed that students responded positively to technology. Furthermore, while the principal liked the units, she felt that three per year was too much for a teacher to implement, and that one or two would be much more reasonable.

Teachers said that preparation was a time-consuming component of the STC units. The lab teacher also agreed that preparing the lab for experimentation took a great deal of time. In her opinion, time constraints were an especially huge challenge for non-departmentalized teachers. The teachers also commented on the amount of time it took to teach a unit. It was suggested that the units be broken up into modules that were more manageable.

Lastly, the site coordinator wished they had everything they needed in terms of materials at the school because they did not always have enough from the previous year. However, she did point out that, when she asked the regional coordinator for additional materials, they arrived very promptly.

Implementing LASER i3 in the Classroom

"They [students] get really excited when we say 'science,' " said a first-grade teacher.

Teachers felt that the students now liked science and enjoyed working with the units because of the "hands on" learning activities. The site coordinator appreciated how the exposure to more math and science helped under-represented minority students make connections with the real world, saying, "Start at the elementary to give them the skill sets so they can do these things. Watching them make the connections, conducting experiments, taking notes—it encourages us to continue teaching science." Other benefits mentioned during the interviews were that LASER i3 program provided a rich learning environment, as well as increased level of student engagement, particularly among students who were struggling academically.

During the 2013-2014 interview, the new site coordinator thought that ESL students were benefiting from using the inquiry-based approach, and in describing an ESL classroom, in which first graders were using the *Solids and Liquids* unit, she said, "It was really good to see an ESL teacher do science. The fact that they were allowed to experiment, compare and contrast—it scaffolded their learning. The kids really got into it. I saw some of their work and it really helped them with skill sets and language a lot."

However, the principal said, "I have not gotten feedback that the ESL are having trouble, but there are concerns. We would benefit more if they would translate all units into Spanish for the lower grades."

The ESL teacher felt that, because her students were bilingual, she had to commit more time for teaching the vocabulary before she could proceed with the STC lesson. This approach caused the lessons to be longer. Also, the units were not bilingual, and there were only a few

resource books for Spanish-speaking children, which also presented a problem for a school with a large portion of ESL students.

Because the school integrated writing, the journals were appreciated, and it was mentioned that every grade was using them. However, the first grade teacher had concerns about how the STC unit could be more "kid friendly." She felt that many first grade students struggled with writing, and thought the assessments would be more helpful if the student could verbalize an answer or draw a picture instead of write out an answer. Furthermore, while she thought the STC lessons covered a variety of the TEKS standards, she also did not feel the two-question assessments provided the teachers enough information to know if the students had learned concepts and vocabulary to prepare for their end-of-year testing.

Finally, it was expressed in the interviews that parents had shown a curiosity about the lessons and experiments. One teacher mentioned that she had a couple of parents ask if they could volunteer during science so that they could see the STC units in use.

Moving Forward

Teachers thought that the principal supported and valued science. In regard to the school's needs and resources for sustaining the LASER i3 program, the principal mentioned wanting a central location for the storage and refurbishment of materials.

The principal added, "The district received a lot of money. The kits are great, but when we consolidate, sometimes there are resources left over. Not just kit materials and supplies, but manpower. It would be great to have a consultant, a LASER consultant. We don't have an ancillary position. The consulting piece can be a coach and provide PD to the teachers."

The school staff wanted a more "customizable" approach, where they could teach units when they wanted, as well as use them in different grades. Also, the site coordinator felt that, if

the STC curriculum were more aligned with the state assessment and standards, teachers would find it easier to incorporate them throughout the year.

"I just want to see it get honed in and tie it to the scope and sequence so teachers do not feel anything is being left out. When you're not doing well on a district test, people look to see what you missed."

Conclusions

Generally, the staff liked the LASER i3 program. Those teachers who attended the summer PD felt it was beneficial, and they enjoyed being able to collaborate with other teachers during the session. If a teacher was unable to attend the summer PD, the site coordinator provided some training and paired them with another more experienced teacher who had attended PD.

Teachers were working more closely together due to LASER i3. Previously, teachers planned just for their classroom; now, there was grade-level and school-level planning for science. The principal felt the district was putting more emphasis on science because of the LASER i3 program, and she personally valued science and wanted it to be a part of every teacher's curriculum. Interestingly, even some parents expressed an interest in participating in science because of the units.

Teachers also thought the STC program provided the school with high quality educational materials. In their opinion, the lessons were well laid out and provided them with all the needed materials for teaching a science lesson.

Furthermore, teachers felt students enjoyed the hands-on inquiry based approach and were more engaged in science. It was believed that having more real-world science and math examples available to minority students not only introduced them to new concepts, but better

prepared them for the future. Strengthening the skill sets and vocabulary for ESL students was also thought to be addressed through the STC curriculum.

However, there were some suggestions and complaints. While teachers felt the units provided all the needed materials to prepare and teach a science lesson, they thought that preparation was time-consuming, and the lessons took longer than anticipated. Moreover, teachers thought it was a challenge to cover everything in the STC units in addition to material relevant to the state standards. Lastly, the principal felt three units to cover in one year were too many for teachers, and would have preferred only one or two per year for each grade level.

With regard to the large population of ESL students, some of the teachers felt they were benefiting from the hands-on learning; however, the principal and ESL teachers wanted to see more of the lessons materials translated into Spanish. The ESL teachers had to take more time to teach the vocabulary for ESL students, which resulted in longer lessons.

There were also concerns raised regarding the assessments for first grade students. One issue was that first grade students had trouble writing at any length about what they had learned; the first grade teacher suggested that a verbal or drawing assessment might be a more effective alternative for this grade level. Also, because the assessment was so short, the first grade teacher did not believe that she was able to fully assess what the students learned in preparation for the end-of-year test. Finally, the staff would have liked the freedom to use the units in different grades and at different times of the year.

The school showed marked improvement with PASS Assessment scores. There was an increase in MC scale score (16%), OE percent correct (55%), and PT percent correct (33.5%) from Spring 2012 to Spring 2013. From Spring 2013 to Spring 2014, their PASS MC scale score increased again (14%).

HISD Case Study C (HISD-C)

A site visit of HISD-C (grades PK - 5) was conducted during the 2012-2013 school year. However, for the second year (2013-2014), the school opted to not participate in the case study visits. Interviews were held with the principal, site coordinator, and three teachers during the first year. Some informal observations of classrooms were also conducted. Unless otherwise noted, any findings or assertions made in this report are based on those site visits and interviews.

Background

One reason that this school was selected for inclusion in the case studies was because it had a medium proportion of Hispanic students and students with limited English proficiency. With a total number of students of about 600, about 51% of the students were Hispanic, and according to the principal, about one-half of those students were Spanish-speaking (ESL). Other than Hispanic, approximately 46% of the students were African-American. About 8% of all of the students received special education services.

The school was a Title I school, and over 90% of the students qualified for free or reduced-price lunch. The school was zoned for three apartment complexes, and according to the principal, student mobility was high. The principal added that parental involvement was very limited.

The school was also chosen for case study because the students who took the yearly assessment (PASS) had a high percent correct for the multiple choice section in Fall 2011 (baseline). It also had a high z-score gain from Fall 2011 to Spring 2012.

“Science has always been kind of the focal point of everything that we were doing,” said the principal.

The principal provided a brief, recent history of the school. The school was still somewhat new. At the beginning, there were 18 teachers and 300 students. Although it had been expected to grow, the enrollment did not increase. The principal had invested in a lab and hiring a science ancillary teacher; for five years, this science teacher gave the school a very strong foundation in science. However, the other teachers were not as experienced in science, and therefore, did not teach as much science in the classroom. The principal added that, when the students were receiving both science and social studies instruction, they performed well in science, and the school was rated as "exemplary."

In 2009, with consolidation, the student population nearly doubled in size to about 650 students and a bilingual program was added. Furthermore, the science ancillary teacher took a leave of absence, and attention to science decreased during her absence. The site coordinator added that, while all grades were departmentalized in 2011, only the fifth and third grade bilingual classrooms remained departmentalized.

Following 2011, the school reorganized because assessment scores had "dropped dramatically." Moreover, the science lab was by then eliminated, and the science ancillary teacher was moved to the fifth grade to support that grade's assessment issues. In that same year, the school became an Apollo school. According to the principal, becoming an Apollo school meant that, in order to improve academic achievement, they needed to adhere to rigorous instructional standards.

Professional Development and Orientation

After attending all of the professional development (PD) sessions, the site coordinator commented, "It was long, but informative…. There were good points. It prepares you, being proactive, organized, and got me excited."

A teacher shared her thoughts about the two summer sessions, saying, "I enjoy the PD. Last year, it was fun. I was doing the kit portion of it. It was fun to go in it beforehand to get an idea of what was in the kit before we started using it. This year [Summer 2012], it went deeper, and I appreciate that it gave me more information, a deeper understanding, and answers for when I was teaching kids."

The principal echoed similar comments, and said, "They [teachers] appreciated the PD in helping them know what to do the first year [2011-2012]. They knew how to implement their grade level."

However, the principal noted that teachers had some concern about not gaining adequate knowledge about the other units. Because teachers often change grade levels within the school, they thought that the program needed to make training available at other times throughout the year. They suggested hosting the PD sessions on-line, as well as providing a way for lessons to be viewed and downloaded at teachers' convenience.

Based on PD rosters, the school had excellent attendance for the first and second year sessions. However, less than half of the teachers attended the third summer PD session.

Planning and Preparation

The site coordinator thought that the school had been provided with plenty of STC materials from Smithsonian. Because there were some unopened kits, there was a surplus, and this may have been because too many materials were provided, or because some teachers were not able to use a unit.

One teacher said, "I do like the kits because it comes with all the materials. It can be hard to find the materials. I like that the materials are included."

However, the teacher also said, "Finding the time to set up [the kits] can be challenging."

The principal felt that a lack of time was the biggest issue for teachers. Because the school was self-contained and not departmentalized, the teachers had difficulty in getting everything accomplished in a day. Moreover, the Apollo initiative generated a strict curriculum, which mandated a certain amount of time per subject. Because the STC lessons could take longer than the allotted time for science, it was difficult to fit it into their schedule. The principal regularly mentioned Apollo as a road block for implementing the STC units.

On the other hand, another teacher indicated that she adjusted to the 45-minute science block by dividing long lessons across two days. According to the site coordinator, all teachers had attempted to use the units the previous year (2011-2012), completing at least some of the lessons, though they may not have finished an entire unit.

"Teachers are glad to receive the supplies and materials to do science; they just would like to have more time to do it. They can't linger, can't go as deep because of the time," said the principal.

There were also time issues because of conflicts with other priorities. The principal pointed out that fourth grade students were assessed in three areas (math, reading, and writing) and so, the teachers tended to focus their instructional time in getting students prepared for those assessments. As a result, science was not taught as frequently. Furthermore, second grade had to implement *Think Literacy*, with an expectation for the class to focus most of their day on literacy to improve reading scores. A first grade teacher also mentioned her time being affected by *Think Literacy*.

Implementing LASER i3 in the Classroom

At first feeling overwhelmed, students, as well as teachers, met with a learning curve in first using the units; there was an adjustment to being able to time-manage and getting used to

working in groups. However, teachers expressed confidence that learning through the inquiry-based approach would become easier for students, as well as teachers, each year of the project because they would "have a foundation."

All of the interviewed staff indicated that the students "loved" working with the hands-on lessons. Students especially enjoyed *Butterflies, Electricity, Motion and Design,* and *Solids and Liquids*. They enjoyed the activities and learned much from the inquiry-based approach. Still, the principal felt that while teachers appreciated the STC units and saw increased student interest during science, the teachers' interest and energy might wane over the course of the year, saying, "I think that when they are fresh, they would see it has a support for science. As the year goes, and the pressure increases, then they have to prioritize and may put it off."

The principal also mentioned that science was a subject the teachers were asked to teach in English, but it was sometimes difficult. She thought that science vocabulary was the most difficult task for ESL students. A teacher stated that the STC lessons helped with English acquisition; students were introduced to the lesson in Spanish, but then translated and taught science in English. The first/second grade bilingual teacher added that, although second graders were able to fill out the science journal independently, first graders needed assistance.

Teachers felt that, for students with diverse learning and language needs, a key benefit of using units was the hands-on components, and as one teacher said, "They need hands-on; they get excited, and it keeps them engaged. At the end, they were able to tell me what they learned. They were so excited to tell their teacher all they had learned. They need hands-on."

Moving Forward

The principal stated that, to continue the STC Curriculum after the grant period, it would need to part of the district's expectations, incorporated into the district's curriculum, and include

professional development for new teachers. One teacher felt that the PD was essential for new teachers.

This teacher said, “If you do not have experience with a kit, it is very overwhelming. A new teacher without training would not be excited about it at all. To continue, teachers will need PD on the kit they’re going to teach. They need the deeper background knowledge.”

Another teacher described the need for lateral, as opposed to specialized, instructional and functional knowledge of STC curricula: “We were all trained on the kits we use. If I were to leave, the next person would have to read through the binder and that just leaves a hole that is difficult to replace.”

Furthermore, the principal said that she thought that her school would have “a better implementation [of the STC Curriculum] if we departmentalized instead of self-contained,” predicting that ““the self-contained will not get as rich a benefit.” In other words, instead of following a self-contained structure like most elementary schools (meaning one teacher is responsible for teaching four or five subjects to her class), a move to a more departmentalized approach where a teacher is responsible for teaching one or two subjects throughout the day (i.e. math and reading or social studies and science) and rotating classes with another teacher was thought to be more conducive to implementing STC. The principal may have thought a departmentalized approach would give teachers more time to focus on preparation and even become somewhat of a specialist in the content areas they teach.

Conclusions

There were many positive impressions of the LASER i3 program. Teachers said that the PD was beneficial and prepared them to use the STC units. Also, everyone felt that the students

enjoyed hands-on learning. Furthermore, teachers appreciated the STC science materials and lessons, and having these resources available when they were able to teach science.

Nevertheless, as the principal and site coordinator observed, even though teachers wanted to do more with the units, they often did not have the time. The school was focused on preparing students for state assessments (because students were not preforming well), state initiatives (i.e., Think Literacy), and having a strict state-mandated curriculum that dictated how long a teacher could teach each subject in a day (i.e., the Apollo initiative).

"This school has so much going on," the principal summarized.

In returning to the reasons that the school was selected, it is difficult to draw many conclusions from only one site visit. However, there are a couple of items that can be considered. First, the school was selected because of good performances on the PASS (MC) assessments. However, the raw score for the PASS MC dropped about 10%, between the Spring semesters of 2012 and 2013 and it dropped 5% between the Spring semesters of 2013 and 2014. During the 2012-2103 interviews, it appeared that successfully integrating the STC units, as well as time for science instruction, was a challenge within the mandated requirements from Apollo.

HISD Case Study E (HISD-E)

A site visit of elementary HISD-E (grades PK - 5) was done, during the 2012-2013 and 2013-2014 school year. Interviews were held with the principal, site coordinator, and teachers for both years. Some informal observations of classrooms were also done. Unless otherwise noted, any findings or assertions made in this report are based on those site visits and interviews.

Background

One reason this school was selected for inclusion in the case studies was because of its diverse demographics. Of approximately 450 students, about 65% were Hispanic, while 34% were African American. According to the principal, a high proportion of the students were economically disadvantaged. Over 95% of the students qualified for free or reduced-price lunch, and the school was classified as both a Title I and Apollo school.

The principal said, "A lot of our students are not on grade level, in terms of literacy, math, science… or any subject," and added that there was a high proportion of at-risk students.

In regard to parental involvement, one teacher stated, "[Parental involvement is] a strange combination of all the culture of the neighborhood, family support, and language barriers. Some families support and some don't help their children; some help too much and some don't engage enough."

The school was also selected for case study because, for students participating in the summative PASS assessment in Fall 2011, the average percent correct was low, while the average z-score gain in Spring 2012 was high – meaning the students who participated in the PASS showed improvement in their assessment scores from Fall 2011 to Spring 2012.

Prior to the LASER i3 program, teachers stated that science resources had been limited. Most science resources were textbook-oriented, and the text books were said to be "outdated."

Professional Development and Orientation

The professional development (PD) participation roster showed a large number of attendees for the first year. However, participation was lower for the second year (63% lower), as well as the third year (47% lower) when compared to the first year. According to the site coordinator, everyone attended the professional development during the first year, however three or four new teachers missed the summer session in the second year. The site coordinator also noted that some teachers did not like that the PD session was offered in the summer.

The site coordinator said the PD was "great." She felt the it provided her with the knowledge needed to implement the units in the classroom. She also found the PD helped her understand and visualize the use of science journaling. Teachers also found the PD very effective. However, they provided few comments about the second and third year sessions, possibly due to lower attendance.

A teacher said, "Without it, I would not be able to do it [use the STC kits]."

By the third year of the project (2013-2014) the site coordinator/fifth grade teacher had changed. The new site coordinator was a first-year teacher and given the responsibility to manage the LASER i3 project for the entire school; she admitted that the project might not have been getting the attention it needed.

The site coordinator thought that the teachers had viewed LASER i3 as "another thing they had to do," but were embracing it more each year. She felt that teachers were hesitant to use the units, and a little afraid, because they were unsure of the content. She reasoned that some of the teachers' hesitancy might dissipate as teachers grew more comfortable with the units.

Planning and Preparation

The principal explained the district and school curricular focus, saying, "Because we have such a high at-risk student population, there has been more focus on reading. That is a push from the district and myself."

During the first year of interviews, the site coordinator indicated that the district superintendent's focus was on reading. For example, *Think Literacy* was being introduced, and *Read 180* was being used to fill other gaps in reading skills. Teachers noted how much more they taught reading and math; science was on the "back burner" until the fifth grade, when the school was held accountable for students' assessments. The principal described this challenge as a "balancing act," and he said he was considering the addition of more professional learning communities (PLC's) to show teachers how to better integrate science within the reading requirement priorities.

Time was an issue for many of the teachers. By the third year of the project, they reported having more difficulty implementing all three units - they tried to do what they could. Most of them felt that they could not get everything accomplished in a unit, because the lessons usually took longer than the time they had to teach science. One teacher mentioned that she skipped parts of a lesson so she could get finished by the end of class time. Moreover, all teachers interviewed agreed that set-up/preparation required a lot of time.

The site coordinator indicated that alignment with benchmark testing also remained an issue in the second year of the project. The principal added that aligning the STC Curriculum with the state assessment would be most helpful to teachers.

"If we can align them, show them the standards are there, the teachers will be more committed," he said.

A teacher, who had taught both second and fourth grade at different points during the project, thought that there were different levels of implementation, based on grade level. She believed that the first and second grades were implementing the units with fidelity. However, third and fourth had to "pick-and-choose" lessons because they also had to prepare students for the STARR assessment. She also thought that the fifth grade implemented the units with fidelity because they have a dedicated science teacher. However, the site coordinator felt differently. In her opinion, the units were not getting implemented very often, independent of grade level.

Overall though, teachers offered positive feedback regarding their experience of the LASER i3 program. A few commented about how the units provided everything a teacher needed.

As one teacher said, "Everything is already provided. The materials are already there; I just follow the lesson plan in the binder, and it is very structured."

Implementing LASER i3 in the Classroom

Teachers and the principal indicated that their students have enjoyed the STC hands-on inquiry-based approach, particularly the *Butterfly* unit and the *Changes* unit, as one teacher said, "Last year, I did the *Butterfly* unit, and the students really enjoyed it. This year, we started with *Changes*, and they are more excited with *Changes* than they were about the *Butterfly* unit last year. I see the children are very excited."

Several teachers described how the STC curriculum had helped their students with their reading and math, and a few teachers felt it helped students with writing. Additionally, a couple of teachers stated that notebooks were a challenge during the first semester of the year, but that by the second semester, the students were writing more and have less difficulty filling out their notebooks.

Teachers also described their success in modifying the STC units to accommodate the diverse needs of students in special education. The site coordinator thought that teaching students who were below grade level presented challenges; their critical thinking skills were not as developed, and they were reading a couple grades below their current level so the teachers had to improvise at times. One teacher added that the reading level provided in the lessons was "too high" for her students, thus making the instruction process lengthier.

Teachers took varying approaches with students learning English as a second language. Teachers of the younger grades typically used Spanish, as needed. Teaching the units in English and Spanish was not a problem for these teachers. One teacher said that he conducted most of his class in Spanish, with some English, and students were tested in Spanish. The goal was for all students to be fluent in English by the fourth grade, with no instruction in Spanish.

A teacher said, "I do both, back and forth. I don't find it to be an issue."

Another teacher added, "It is good for them to know both."

The site coordinator explained that science was an ESL block in her grade level, so lessons were conducted in English. A teacher in another grade indicated that he also has no need to translate for his students, saying "My bilingual students have a waiver. They have been involved in English instruction long enough that we can conduct the lessons in English."

One teacher explained further that, while the unit lessons were all in English, there was a Spanish link on the website with some of the resources available to print in Spanish. Because of the high population of bilingual students, the first grade teacher suggested that a vocabulary wall with pictures for every unit would be helpful.

Moving Forward

When asked whether she thought that it would be possible to sustain the LASER i3 program at this school, the site coordinator said, "I believe it can happen. It will take the principal's encouragement and his expectation that each grade will complete what they are supposed to so they can move forward the next year."

She estimated that 95% of teachers would be supportive of LASER i3 after the project ends, absent any turnover. A couple of teachers, new to the school in the third year of the project, felt that they might implement it with more fidelity the following year, given that they had become more familiar with their students and the units.

The principal thought that if the time was allocated to show the teachers how they could reinforce reading and math with the LASER i3 program, the teachers might be more willing to use the units in the following years. He also suggested that the program to provide additional support for a new site coordinator. He felt that would help retain the momentum for future years. Finally, the principal suggested that to sustain LASER i3, the curriculum developers should work closer with the district curriculum department, to highlight inquiry-based learning and embed STC into the curriculum and increase the rigor.

The Instructional Coordinator - briefly interviewed in 2013-2014 - said, "It has to show it's working for kids. The research and data has to show that it's working… Then that's what we run with. It's just that we don't have enough of that information to say."

Conclusions

Teachers generally found the summer PD effective and thought that it helped prepare them to use the units. Still, many of the teachers did not attend the PD after the first year. This lack of review and reinforcement may have led to a lack of motivation for using the STC units.

The principal and staff were blunt in that their main instructional emphasis had to be on literacy and math. All evidence suggested that a number of factors were causing the units to be implemented in a very limited way. Science seemed to be low on the priority list, and reading seemed to be the main focus, possibly because the school was an Apollo school.

Still, everyone interviewed felt that the students enjoyed the experiments and were excited in doing hands-on inquiry. A few teachers also felt STC curriculum helped develop students' reading and writing skills. Furthermore, the principal and teachers appreciated that the STC kits provided them with everything they needed to teach science, which seemed to make science less intimidating to teach.

However, the principal felt the STC units were not aligned well with their school's curriculum, which may have resulted in them being used less often. The district wanted the school's focus to be toward reading and math, science was taught infrequently at the school. The exception was in fifth grade, which had some focus toward science because the students were assessed at that grade; for this reason, the fifth grade also had a dedicated science teacher with her own lab.

Although many of the staff did not seem to think it was a serious issue, the site coordinator and a couple of teachers felt preparing the classroom for an experiment took quite some time. Also, many felt the lessons and entire unit took longer than anticipated, which could result in skipping over all or part of a lesson to finish in a timely manner.

Another challenge was the student population. Many of the students at this school were considered "at risk" and performing below grade level. Lessons might have taken longer because the class had to stop and review simple vocabulary words or read the entire lesson aloud. Also, while the bilingual teachers thought their students did well with the hands-on inquiry based

approach, they still wanted a few more resources provided in Spanish, such as word walls with pictures and reading passages.

Returning to why the school was selected for inclusion in the case studies, for the Fall 2011 PASS, the average percent correct was low, while the average z-score gain in the spring was high. In reviewing the PASS's multiple-choice raw scores, the scores dropped over 38% from 2012 to 2013, but increased over 31% from 2013 to 2014, although they were still more than 10% lower than in 2012.

However, the Open-Ended/Critical Response percent correct scores increased by over 16% from 2012 to 2014. In addition, the Performance Task percent correct increased by over 3% during the same time period. Although there appeared to be issues with students' knowledge on the multiple-choice assessment, their ability on the open-ended responses appeared to improve, which may have been related to using hands-on approach, as well as successful integration with journaling.

Also, although STC Unit Logs dropped from *To a Large Extent/Yes or Completely* to *Some/Large Extent* from 2012 to 2014, observed inquiry-based instruction increased from *Rarely/Occasionally* to *Occasionally/Frequently* during the same time periods. Although teachers may not have been using the units with complete fidelity, overall, there appeared to be some increase in inquiry-based instruction.

Appendix B: Summary of Findings in New Mexico Case Study Schools

Regional Background

Four Phase 1 schools were selected for case studies, located in rural areas of northern central New Mexico. Two of the schools are at the elementary level, while the other two are middle schools.

With a community population of about 12,000, one of the schools was located in an affluent neighborhood, close to national laboratories. The median household income for the area was about $100,000, with a poverty rate of only about 3.1%. The other three schools were located in smaller communities (800 - 1,800), with lower median household incomes (about $40,000) and much higher poverty rates (about 24%). These three schools were classified as Title I and included a large portion of students receiving free or reduced-price lunch.

Student mobility was reported as low at all four schools. However, district and school-level administration turnover was high within and between districts.

Located close to Native American reservations and the Mexican border, three of the four schools served a large bilingual population, with many students learning English as a second language (ESL). Native American students lived at nearby pueblos, speaking their native language, while other students were of indigenous Hispanic American ancestry or were Mexican immigrants who primarily spoke Spanish at home with their families.

Children who are born on pueblos typically stay at home through the 6th grade and receive schooling by the family. Because of this, the middles schools get an influx of students from the pueblos which can create challenges for teachers, including cultural differences, lack of science knowledge, and language barriers. Additionally, these parents often fail to recognize

value in higher education and prefer for children to stay on the pueblo and contribute to the community.

Prior to their participation in the LASER i3 grant, instructional time for science was minimal and was primarily instructor-driven and textbook-based. Students experienced little hands-on learning.

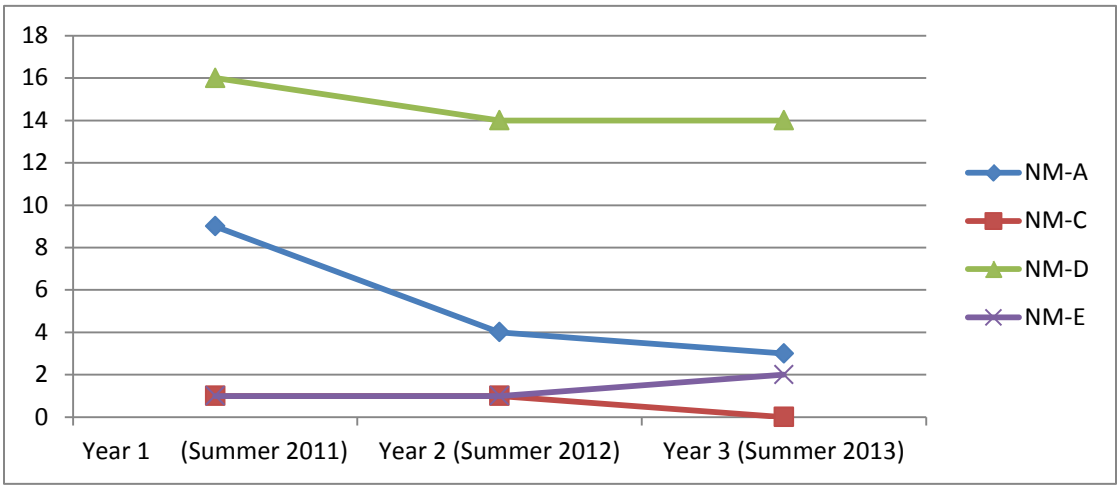
Selection for Case Studies

The four schools were selected as case study sites for several reasons: they had a high proportion of Native American and/or Hispanic students, English language learners, and students receiving free or reduced-price lunch. One school was also considered because of its high percentage of Asian American students, as well as a high average percent correct for the Fall 2011 PASS assessment- relative to other Phase 1 schools in the project.

Professional Development and Orientation

The two elementary schools had the greatest attendance by teachers during the first professional development (PD) session (Summer 2011). By the second year, those numbers declined and stayed about the same for the third year. The middle schools (NM-C and NM-E), which typically have fewer science teachers because of being departmentalized, had a teacher from their school attend the first and second summer PD; however one school had no one from their school attend the last PD (Summer 2013). See Figure 13.

Figure 13: Professional Development Attendance for NM Case Study Schools



Those who attended the PD said it was beneficial; it showed them how to prepare for the STC materials, how to set up experiments, what to expect, and some of the challenges that they might encounter. Furthermore, after attending PD, teachers thought that not receiving the training would result in difficulty with using the units.

Five major suggestions were made for improving the summer training sessions:

- work with districts to schedule training sessions to better accommodate differing district calendars
- communicate and coordinate with districts and schools regarding training earlier in the year;
- consider traveling distance and family needs when choosing training locations;
- offer college course credit for participation in training;
- align training that teachers receive with the units that they will teach.

Planning and Preparation

Generally, teachers thought STC units were well-organized, understandable, user-friendly, and aligned reasonably well with the current standards. An exception was the *Sound* unit, which teachers thought was not age appropriate. They also agreed that everything in the STC unit was typically provided, with exception of the "needed but not supplied" materials, which were difficult for some teachers to purchase due to the schools' proximity to stores that could supply those materials. For instance, teachers had to buy soil and 55 pounds of sand for lessons that required those materials, which was an issue.

Two schools felt the need to supplement with reading material to provide their students with additional background knowledge, which was something many teachers felt students from a diverse background were missing. One school had to modify some of the units to fit their own style and needs. For example, a teacher modified the instructions of a lesson, while another teacher used her own assessment, games, and videos.

Additionally, teachers from two schools were missing the teacher's manuals; either because they were new to the school, or they were representing multiple grades and could not attend more than one grade-level summer training at a time (teacher's manuals were provided at the summer training). Because a teacher's manual was not provided, one teacher chose not to teach from a particular unit until she received the manual. Moreover, a couple of teachers stated that it seemed to take a long time before they received those materials from Smithsonian. However, another school reported not having issues with receiving materials on-time.

Everyone noted that lessons required fairly extensive preparation; in particular, material preparation and setup were time-consuming for most of the elementary teachers. However, one

teacher chose to use setup as a way to get parent volunteers involved in science by inviting them to help prepare the room for the experiment.

In addition to extensive preparation, it was a challenge for many teachers to fit everything into their day (e.g., teaching 4-5 subjects, language classes, interventions, and STC lessons). Teachers had state standards they felt had to be covered by the end of the year, and many struggled to implement all the units. Specifically, the elementary schools reported that there was not always enough time to teach science, either because they needed to focus on math and reading or an STC lesson took longer than the time allocated for science (e.g. 45 minutes). One teacher, in particular, felt this delay was due to many of the students being "below grade level," and therefore, they needed to take the subject at a slower pace.

A few teachers admitted to skipping lessons in a unit to get completed in "a timely manner," while, because of time constraints, science sometimes got "dropped." One elementary school attempted to teach all the units by the end of the school year, whereas the other elementary school implemented with the STC lessons with fidelity because teachers felt the principal had given them no other option. Because many of the teachers were only able to get two of three units taught during the 2013-2014 school year, some planned to teach the third unit during summer school. In contrast, some of the upper-level elementary (grades 4 or 5) and middle school teachers had fewer issues with time, which might have been because they were only responsible for teaching one or two subjects.

Implementing LASER i3 in the Classroom

Schools varied in their progress for implementing the units. Two schools believed that they implemented it with as much fidelity as they found possible, while another school had shifted some of its focus from LASER i3 (i.e., science) to reading and math in the second and

third years. One school had almost stopped using the units by the third year, and instead, concentrated on using a new science textbook that the district had bought for the school.

Overall, teachers enjoyed the hands-on manipulatives, and most felt the students loved working with the STC materials, which encouraged the students to become more engaged in science. Learning science beyond textbook lessons was considered beneficial by some teachers and principals because it better introduced students to real-life situations and higher-level questioning. Teachers also thought everyone benefited from group work, through student-to-student interaction; in many instances, higher performing students helped other students. Moreover, many of the staff felt students were seeing and using scientific vocabulary more often and were able to practice organizational writing skills through science journaling.

Teachers also saw their at-risk or ESL students excel when using hands-on materials. These students were immersed in an activity that kept them interested for longer periods of time than traditional instructional methods did. However, two middle school science teachers (from different schools) did not think their at-risk or ELL students liked working with the units because they were too difficult and overwhelming. One teacher said her at-risk students would specifically ask to copy notes out of a textbook instead of participate in an experiment. The other teacher stated that the language barrier was so large that students would "shut-down" during experiments, and he suggested that a Spanish version be provided for those students who were having difficulty with language.

Middle school science teachers reported other challenges. For example, students' cultural or language differences affected the use of inquiry-based learning. Specifically, one school had a substantial percentage of Native American students (55%) who were raised in a culture that expected the teacher to be the only one who taught and talked throughout the class.

This perception became a challenge when using an inquiry-based approach with hands-on learning. Also, many Native American and Hispanic parents were perceived to not value higher education, which could also affect the attitudes of their children.

With the exception of one teacher who felt exposing K-3 students to science helped prepare them for upper grade-level science, both elementary schools felt a need to focus their class time on math and literacy, especially for the younger grades. In other words, they felt the younger students needed to become proficient in reading, writing, and arithmetic before being introduced to science.

Moving Forward

Since the start of LASER i3, there had been a lot of administrative turnover, as well as teachers transferring to different grades within the schools. Because of the high staff turnover, many worried that a lack of support and continuity would impact the future of STC units. However, because many of the schools were near locally-based national laboratories, and they understood that Los Alamos National Laboratory (LANL) had agreed to provide future support, principals were hopeful that funds would be easy to secure for future material refurbishments and/or professional development.

Still, because it seemed that little had been communicated from Smithsonian and the district to principals and teachers, many of them were unsure about the future of LASER i3 at their school, and were unable to discuss how/if the units would continue to be implemented after the grant. Because of the lack of communication, one middle school did not think LASER i3 was important and rarely used the STC units by the third year of the project (2013-2014). Instead, they focused more on what they felt was important to administrators.

Furthermore, teachers thought that new standards would dictate whether they used the STC units in the future. While New Mexico had adopted Common Core standards in October 2010 and Partnership for Assessment of Readiness for College and Careers assessment (PARCC) in Fall 2011, many of the case study schools had not. However, in the last year of the project (2013-2014) teachers began preparing for these changes because districts had asked for full implementation by the 2014-2015 school year.

Selection for Case Studies – Summary

In revisiting the reasons for selecting the schools for case studies –PASS scores changes--there were mixed results. Though a couple of schools showed some slight gains, the other two showed little change over the three years of implementation. Also, the two schools that had site researchers conducting multiple science class observations over the school year did not show much improvement in their inquiry score from one year to the next. One school's inquiry score actually decreased each year of the project.

Again, it should be noted that most schools were chosen because of a high proportion of ESL students. Issues with language and vocabulary, along with other cultural differences, might help explain some issues with low fidelity and achievement.

Phase 2 Schools Summary

In 2013-2014, two Phase-2 schools were selected for case studies. Both schools were large elementary schools with 400 or more students. The student population was predominately White (55%) or Hispanic (33%). Neither of the schools was classified as a Title I school, and they had less than 25% of students receiving free or reduced-price lunch.

A primary reason that both schools were selected was because of high PASS scores. One school did well (relative to other schools) the first year, however showed little gains in PASS

scores after that. There appeared to be flexibility in teaching science at this school. Teachers could use any materials they wanted for teaching science (e.g., kits, workbooks, and/or textbooks), as well as cover as much/little as they would like. The school's focus was toward teaching the New Mexico standards so that students would do well on state achievement tests. Some teachers expressed concern about science instruction and were very willing to attend the summer PD, receiving the free science materials, yet seemed to understand little about their school's role with LASER i3 in the following year.

The other school was selected for case studies because it showed improvement in all PASS scores (MC, OE, and PT) from Spring 2012 to Spring 2013. In this school, too, teachers were given a good deal of freedom with how to teach science, using the Internet as a resource. The teachers were open to discussing the science curriculum and instruction, and most of them expressed a desire to keep with the status quo. They enjoyed the freedom to create their own lessons and materials.

NM Case Study A (NM-A)

A site visit of NM-A was done during the 2012-2013 school year, and then another during the 2013-2014 school year. Interviews were held with the site coordinator, principal, and teachers (generally, through focus groups from each grade that participated in LASER i3). Some informal observations of classrooms were also conducted. Unless otherwise noted, any findings or assertions made in this report are based on those site visits and interviews.

Background

There were several reasons that this school was selected for case study. One, the student population was comprised of a high proportion of Native Americans (~87%) and English Language Learners (ELL). The majority of the students lived at a nearby pueblo; however, the community population surrounding the school and pueblo was mostly Hispanic (~62%). Due to the high percentage of Native American and Hispanic students, the school served a large bilingual population, with most of the students classified as ESL (English as a Second Language). At home, students typically spoke Spanish or the language of their Native American tribe.

Another reason that the school was selected for study was that it had a high proportion of students receiving free or reduced-price lunch; in fact, 100% of the students qualified for Title I services. Although all students qualified for free or reduced-price lunch and the poverty rate for the community was almost 24%, the median household income was about $43,000, which is comparable to the state of New Mexico. Economic hardship was suggested to explain low parental involvement at the school: parents might lack transportation or money for fuel and/or have to work two jobs.

Though the school was located about 12 miles from a larger city, it was situated in a very small community of about 800 people. The principal mentioned that student mobility was low. Though the small student population had grown in the last several years, its numbers were otherwise stable. At the beginning of LASER i3, the school had one classroom and teacher per grade level; by the end of the project, the school had one or two grades with two teachers. Teachers were often changing grade levels within the school. While this school was relatively stable, administrative turnover was high across the school's district. The principal reported that, in her six years working in this district, there had been three different superintendents.

The reported science education measurements at the beginning of the project for this school showed mixed results. The observation of inquiry-based lessons was low (*Not Observed/Rarely*), and the 3rd grade's Fall 2011 PASS percentage correct was low when compared to other schools in the study. However, the Spring 2012 PASS gain (an average z-score) was high.

Prior to LASER i3, it was reported that science lessons were often skipped. If science was taught, it was typically from a textbook; students would read a chapter and then answer questions at the end of the chapter. According to the site coordinator and principal, the hands-on learning method had rarely been used. Though the school had been provided science kits prior to LASER i3, the kits had not been used, but instead stored in a room.

Professional Development and Orientation

Although most teachers attended the first year of professional development (PD), attendance for the following years dropped; the principal stated that the PD did not fit well into the staff's schedules for the second and third years, and, according to the PD rosters, less than half were able attend for each of those years. Some teachers stated that one week of training was

just too long and intense. A few teachers who did not attend the summer PD felt they were able to read through the STC materials and successfully prepare themselves to teach a science lesson.

The site coordinator agreed that very few teachers attended the 2013-2014 school year PD session, and it was difficult to find available time for a condensed, half-day session, which she taught. Furthermore, she found it difficult to teach an entire week of PD content in four or five hours. A teacher who attended the half-day condensed kit training said that she would have liked more training. Nevertheless, because her training was in early childhood education, with little background knowledge in science, she felt the condensed PD eased her anxiety about teaching science.

"I needed the hands-on to do it first before I teach the kids," said the teacher.

Some teachers commented about the benefits gained from attending the PD session. Teachers who attended the PD enjoyed doing the experiments and felt less apprehensive after seeing how much training and support were provided. One teacher liked seeing every lesson executed because it gave her a better idea of how long it would take her to set up the classroom. In implementing the STC units, teachers enjoyed the hands-on manipulatives and liked how everything was provided, laid out, understandable, and user-friendly.

Another teacher said, "Everything is there to teach a unit, and it's laid out very well, easy to follow."

Preparation and Planning

Along with wanting to prepare students for the Standard-Based Assessments (SBA), the site coordinator mentioned that the district wanted the most emphasis for instruction to be toward math and reading. Math and reading were both taught in 90-minute blocks, with an additional 60 minutes for interventions (i.e., resources for underperforming students). Physical education, art,

and music classes were also taught daily. Every afternoon, teachers met to discuss content in math, literacy, and technology. Though required to teach math and literacy, teachers said that science was not mandated, and so, because it was not considered a requirement, it might get "dropped" on busy days.

All subjects were taught with a focus on language. Recognizing that the language of their heritage was at risk of being lost, most parents chose to enroll their students in 45 minutes of daily instruction in either Spanish or their family's native language. As needed, content area vocabulary and concepts might also be reinforced during that time.

By 2013-2014, the principal felt that one of the biggest issues for teachers was not having enough time to teach science. Though, she strongly encouraged teachers to teach it every day, or at least integrate it with literacy lessons, teachers still felt they could not find enough time to fit it into their schedule. A few teachers admitted to skipping lessons in a unit to get it completed in "a timely manner." Because most of the teachers were only able to teach two of the three units in 2013-2014, they planned to teach the third unit during the 25-day summer school session, which, according to the site coordinator, about half of the students attended.

Still, the principal had seen more science instruction in the school with the introduction of LASER i3 program. Though she said that she had "let science slide into the backseat," she said she would like to see science taught at least twice weekly. She thought that some instructional time could be taken from math or reading to provide more time for science. The site coordinator added that the principal's new plan might include reserving the last hour of the day for science.

Because of everything that was required to conduct an STC lesson, the principal and site coordinator indicated that teachers felt challenged, not only with regard to instructional time, but

also with preparing the classroom. Teachers said that the setup and material preparation was time-consuming, particularly for the *Circuits* lesson. They perceived that teachers were anxious about making mistakes or interacting with the live specimens.

Also, while most of the units had the required materials, there were a few materials that teachers had to find or purchase (e.g., fifty-five pounds of sand, gravel, yarn, 3 soda bottles per student) and they did not think that procuring additional materials was something that teachers should have to do. Also, because teachers did not always return objects from a lesson, sometimes pieces were missing for the next teacher who tried to use the kit.

Although the third and fifth grades had started using units during 2012-2013, because of difficulties with unit materials, as well as the need to reorder some of the live specimens, the other grades had some delays in implementing the lessons. However, by the last year of the project, all of the grades had started using at least some of the units.

Also, because most the teachers did not attend the summer PD in years two and three, they did not have the teacher manual for their units. The site coordinator and a couple of teachers remarked that it took "a long time" before they received those materials from the Smithsonian.

Implementing LASER i3 in the Classroom

"They love science….The kids absolutely love it," said the principal, and most of the staff indicated that the students were "really excited" about kits and "loved them."

Teachers reported that students were "very engaged" in the *Plants* and *Forces & Motion* materials as soon as they began setting up the lesson. Teachers found it pleasant to listen to the students actively participating in the inquiry process, taking role ownership, and making real-life connections with the lessons.

The site coordinator also thought that "at risk" students became more engaged in science. One teacher stated that students who were typically pulled out for interventions did not want to leave the class with their assistant while a STC lesson was being used in the classroom; the principal has since ceased implementing student pullouts during the afternoons.

Teachers liked how the lessons moved progressively deeper into the topics. They appreciated the journaling component, which they used to track student learning. Staff noted that students were going home and using the "language of science," thanks to the expanded use of scientific vocabulary offered through the STC curriculum.

"I like the LASER i3; particularly because they have the literacy component," said the principal.

The principal said that she was very happy with the level of LASER i3 implementation going on throughout the school. She also felt that the units aligned well with the current standards. She stated that the fourth-grade students were doing well in demonstrating an understanding of science and using the notebooks, and also did well, the previous year, in third grade. As long as teachers implemented the units and used the notebooks with fidelity, she believed that the school's state assessment scores would increase in both literacy and science.

Moving Forward

As potential funding sources for STC refurbishment (post-project), the principal was considering Impact Aid and possible LANL grants. Still, the principal was not sure if the STC units would align with new requirements that were being introduced to address a new standards-based assessment (i.e., PARCC). The teachers, too, felt that the new Common Core Standards would dictate the use of the units, moving forward.

The principal indicated that continued professional development needed to be addressed, and that PD was necessary and valuable. So that teachers would continue to use the STC units, the principal planned to be very strategic about future scheduling and giving teachers the time they needed to properly teach science. Still, generally, most teachers were unsure if they would be able to use the units after the project.

Conclusions

Several challenges emerged for this school in implementing LASER i3 program. Along with some uncertainty about the future use of the STC units, there were concerns about the unit's alignment with the curriculum. For example, in order for students to perform well on the Standards-Based Assessment, the district focused more toward math and literacy, which in turn became a priority for teachers. Moreover, while the staff thought the STC units worked well with the current standards, they were unsure of how well they will align with the new standards and PARCCS assessment, which could affect the future use.

Time for material preparation and for fitting the science lesson into daily instruction were other challenges. The management of materials between lessons could be an issue; following a lesson, some teachers might not properly replace all materials, which caused problems for the next teacher using the kit.

However, teachers commented on how well-planned and easy to follow the lessons were. With the exception of "needed but not supplied" items, teachers also appreciated that the kits came with everything to complete an entire unit. Though few teachers attended the professional development after the first year, those who attended the summer PD felt it was beneficial and prepared them for teaching STC lessons in the classroom.

Students were reported to love the hands-on inquiry based method, were able to make connections with "real life" concepts, and were, in general, more engaged in science. Through the lessons' hands-on approach, "at risk" students, too, found science more intriguing. Furthermore, school leadership appeared to like the STC units, and thought that the used of inquiry-based learning for teaching science was beneficial for teachers as well as students. Students' science vocabulary also appeared to become more developed since the introduction of the STC units.

In briefly considering reasons that this school was selected to be included in the case studies, a couple of points should be considered. One reason that the school was selected was the mix of outcomes in the PASS assessment and observed inquiry-based science. Though the observations of inquiry-based lessons continued to be low (*Not Observed/Rarely*), there were some changes in the PASS assessments from 2011-2012 to 2013-2014. Although the multiple-choice scores dropped by about 4%, both the open-ended and performance-task scores increased by about 7%. It is also notable that the school was chosen because of its high proportion of English Language Learners. It is possible that the emphasis on science vocabulary, along with an increased engagement using the hands-on approach, helped increase the open-ended and performance-task assessment scores.

NM Case Study C (NM-C)

A site visit of middle NM-C was done during the 2012-2013 school year, and then another during the 2013-2014 school year. Interviews were held with the site coordinator and two science teachers, while the principal was only available for an interview during the first year. Some informal observations of classrooms were also done. Unless otherwise noted, any findings or assertions made in this report are based on those site visits and interviews.

Background

A reason that this school was selected for inclusion in the case studies was because it had a high proportion of English Language Learners (ELL), as well as a high proportion of Hispanic students (~93%). Unlike other case study New Mexico schools, there were no Native American students. Almost all students were of indigenous Hispanic American ancestry or were Mexican immigrants.

From the interviews, it was noted that some students were very detached from school because they were unable to read, and so, had difficulty with understanding the lessons. Moreover, many students did not complete homework because, as one teacher said, “When they leave here, those books are closed until the next morning.”

Another reason that the school was selected for case study was because it had a high proportion of students receiving free or reduced-price lunch. The poverty rate for the local area was about 24.7%. All students at the school qualified for free or reduced-price lunch, and it was noted that a “very high” proportion had additional risk factors, including broken families, childcare responsibilities, and homelessness.

With low student mobility, the school served an ethnically diverse, small rural village of less than 1,400 people. There was no cell phone service and very little access to local

businesses. The school community was described as being "very dynamic" and "like an urban school in a lot of ways."

All school facilities and district offices were located within the same compound, and the principal of the middle school was also in charge of the high school. There was only one elementary, middle, and high school within the district. Students were bused in from up to a 10-mile radius. This school also accepted students who had been "kicked out" of a neighboring school not in the same district. These students were accepted for a nominal tuition fee.

Regarding parent employment, one teacher said, "[It is] strictly blue collar or below, with few parents having attended college."

It was noted that there was a lack of community involvement, and parents were not visible on campus. Very few parents spoke English, and there was "marginal" parent involvement in their children's education, mainly with regard to grades.

Still, the principal thought that the turnout for the parent-teacher conferences were very good, saying, "[Parents are] definitely interested in what kids are doing."

It was also pointed out that students were less college- or career-minded and more settled in the path of following in their parents' footsteps, which further reflected their levels of interest and engagement in school. Proficiency scores were low for all subjects, according to the site coordinator. Frustration over these conditions was said to reflect high levels of teacher turnover. Administrative turnover had also been high at this school, with four new principals within five years.

Final reasons that the school was selected for case study were because of student outcomes and inquiry-based lessons observed. The average gain in PASS assessment scores, from Fall 2011 to Spring 2012, was high. Also, the average score for STC unit logs was high.

According to teachers, before LASER i3, science education was only textbook-based. There were very few activities provided in the textbook, but not many. Any activities that were provided were reported to be "not conducive to hands-on at all."

Professional Development and Orientation

Because teachers felt unaware about LASER i3 expectations or the summer professional development (PD), they received very little training for the STC units. The principal also surmised that there may have been little commitment to the summer training because the school had an extended school year (i.e., until the end of June). For this reason, teachers expressed dissatisfaction with the summer training schedule.

One teacher mentioned having a prior engagement for a degree program, which conflicted with the upcoming summer training, saying, "This is my summer. If you want a nice, refreshed, prepared person, do not do this to me."

The teachers were also resistant to attending condensed kit training on the weekend - as one teacher said, "My weekends are my weekends. It's my time with my family."

"My Saturdays are precious," said another teacher.

One teacher was willing to attend training during the school day, or some other arrangement with the district, which would allow teachers to attend training during normal working hours. This teacher expressed irritation that such support had not been provided.

Teachers were aware of how missing the PD sessions could impact their instruction effectiveness. One teacher noted that, because he had not attended any of the summer PD sessions, he was not sure how the units were used in the classroom; he was only able to complete one lesson from the three units he was given in 2013-2014. Another teacher, who received training during the first two years, missed the last year. Because he missed the last PD session,

he did not feel prepared to teach the units as well as he did the previous years. This situation was further complicated by switching to a different grade level in the last year.

Planning and Preparation

In describing the beginning of LASER i3, the site coordinator said, "[It was] kind of a nightmare … The superintendent approached us, said that they have contacted us, and we need to do this. It was two weeks before the first meeting. You did not really have time to think about whether you really wanted to do this. I was the only middle school science teacher at the time."

Two new teachers commented about how they had not heard about the STC curriculum until about a week before the start of school. As the site coordinator helped them acclimate to the STC material the first year, the teachers used the existing textbook to teach science.

One science teacher felt that, if the LASER i3 program were important to the school or district, it was never communicated to him. He had a new textbook to use in the science class that aligned well with the current standards and he had little time to determine how to integrate the new units into his classroom. His main focus was using the textbook, which he felt pressured to teach from because of the money spent for purchasing the books. Because the science textbook did not supply any of the materials for labs, he did use materials from the STC kits for any labs he conducted.

Generally, the units included all needed materials, and the site coordinator reported that orders of live specimens or additional materials had arrived at the school in a timely manner. However, one teacher had found a need for many more sandwich bags than were initially anticipated or advised for one lesson.

One teacher shared, “There has to be more meat. There’s a lot of great stuff. Almost like your lessons plans are done as far as labs and stuff, but I have had to supplement the STC book because of poorly explained content.”

Teachers were particularly concerned about the alignment of the STC units with state standards, Common Core, PARCC, as well as with their new science textbook. One teacher stated that, if he felt comfortable with the new science textbook and standards, then, in the future, he might be able to incorporate the STC units into his classroom.

Teachers explained that they did not think that the STC content currently aligned with the state standards, and were “just all over the place.” Specifically, they thought that the timing in the STC books differed from the scope and sequence in the standards. After covering lab safety, the few teachers who were using the units indicated that they had been “skipping around” to find lessons that aligned with the standards.

Implementing LASER i3 in the Classroom

From watching students work with the *Electric Circuits* unit, the principal said, “[Students were] really having fun with it. They were really enthusiastic about it. Any time you can do something other than read a book; of course students like hands-on.”

She added, “[The STC curriculum] is a good thing for [the school] to have … [teachers] like it because it doesn’t cost any money … [they] appreciate the materials and like hands-on.”

Teachers confirmed that they liked the open-ended, inquiry-based experiential approach (e.g., “when you do this, what happens?”). Each teacher added that they thought the STC materials were of good quality.

Teachers also observed that the lessons encouraged some students to move around the classroom, table-to-table, to help other students. Some teachers thought that the group work

helped at-risk and ELL students. A student that understood the lesson would be teamed with an at-risk student. The approach helped to better engage the at-risk students.

One teacher said, "Our students at this school are pretty low-performing. Anything you can do hands-on has got to be better."

Although the students seemed to enjoy the inquiry based approach, there were some concerns raised about the lessons. For example, teachers thought that not all of the STC books began with the scientific method and lab safety, which the teachers said are necessary starting points for all students, especially for students who are at-risk, because lab safety can become challenging for them.

One teacher stated, "I don't feel that topical units work as well for math or science. There is so much essential foundational content and scientific thinking that students don't get from STC books. You can't think with depth without a proper knowledge and thinking base. You need to have the 'big picture' before you can have the 'little picture.'"

Furthermore, there were concerns that the vocabulary was far beyond the abilities for some of the students. Even good students were thought to be challenged by some of the concepts and terminology. Particularly for the school's region, teachers felt that ELL student needs had to be addressed. Overwhelmed by the content and materials, they were concerned that ELL students would just "shut down." However, over-simplifying the vocabulary for ELL students might cause non-ELL students to become bored or disengaged.

Moving Forward

During her interview, the principal stated that her next steps were to read the strategic plan, follow up on the school's progress toward meeting the stated goals, and obtain feedback from teachers regarding which parts of the program were used, which components of the

program were the most effective, and the expected cost to replenish them. The principal expressed confidence in her ability to cover the replenishment of consumables, and teachers also indicated that most of the supplemental materials could be easily obtained. The principal saw LANL as a current, as well as invested supporter of LASER i3. She speculated that another locally-based national laboratory or a local utility company might also want to partner with the school in sustaining the project after the grant period.

However, teachers were not as optimistic about there being a future for LASER i3. They described a pattern that they had observed in the success of new programs formerly implemented at the school, as one teacher said, "The school gets one thing and it goes all gung-ho for a month, and then it's something else."

Though one of the science teachers shared that he wanted to utilize the units and felt that they were beneficial for students, teachers thought that they needed more support from the administration and the district in order to teach the LASER i3 units effectively. The site coordinator also expressed concern for the future of the STC units at the school because of the many changes that he anticipated for 2014-2015: The coordinator would be transferring to the high school, one science teacher was searching for another job, and the principal was moving into another position.

Conclusions

Overall, this school did not seem invested in the LASER i3 program or the units. Anticipating changes that would occur by the 2014-2015 school year, the site coordinator was concerned that few people would be left who knew about LASER i3. There was a high staff turnover at the school. Teachers transferred to other schools, the principal had changed four times in five years, the superintendent had only been in his position for a couple of years, and

teachers were shifting grade levels and subjects. Also, one of the only remaining science teachers had never attended a Smithsonian PD.

Generally, teachers received little Smithsonian training. Two of the three science teachers received no training and were not willing to give up any of their summer or a Saturday to receive future training; however, they were willing to attend a PD during regular work hours. Teachers felt that they were not well-informed, in advance, of the expectations for the STC program. Moreover, they felt they needed more support from their administrators.

Although they liked the inquiry-based approach, teachers were reluctant to implement additional science instruction, over and above the use of the new textbooks. Science teachers felt it was necessary to align their curriculum with the new textbook, as well with New Mexico standards and Common Core before trying to implement the STC curriculum.

Still, teachers felt that the students enjoyed the STC experiments, and thought that the inquiry-based approach was beneficial for the students; in particular, hands-on learning was good for at-risk students. At-risk students could also benefit from group work. Moreover, higher-performing students might also benefit by working between groups and helping at-risk students.

However, teachers observed that most students were not motivated to learn and were not performing at grade level. Specifically, they felt that the STC units did not sufficiently address the ELL students. Because some students did not speak English, reading and vocabulary was difficult for many of the students.

Briefly returning to reasons that the school was selected for inclusion in the case studies, there was little change in the multiple-choice PASS scores from 2012 to 2014. Moreover, the school did not participate with STC Unit logs in 2013-2014. The issues that the school had with integrating the STC lessons with their standards and textbook, compounded by the language

barriers with ELL students, might explain why PASS scores did not increase and STC unit logs were not completed.

NM Case Study D (NM-D)

A site visit of NM-D was done during the 2012-2013 school year, and then another during 2013-2014 school year. Interviews were held with the site coordinator, principal, and teachers (generally, in the form of focus groups from each grade that participated in LASER i3). Some informal observations of classrooms were also conducted. Unless otherwise noted, any findings or assertions made in this report are based on those site visits and interviews.

Background

One reason that this school was selected for inclusion in the case studies was because it had a high proportion of Asian students (~7%) when compared to other schools in the region. With a community population of about 12,000, the school is located in a very affluent county (poverty level was only about 3.1%; median household income in 2012 was over $100,000). The principal noted that, due to a highly scientific community, science education was very well-supported and said, “The kids in this district are higher [intellectually advanced] than other places and come from home environments where learning is valued.”

“I’ve got an electrical engineer that comes in and fills glue bottles because she’s a mom,” she added.

Although the school is located in an affluent community, the school serves a diverse population which includes families living on a nearby mesa in Section-8 housing, families from outside of the district (about 25% of students), non-English speaking parents, as well as parents that work as professional scientists. With the principal’s help, free and reduced-price lunch eligibility was piloted in 2011-2012. She estimated that about 20% of the student population was eligible for this service; however, this percentage was not high enough to be eligible for Title I and other funds.

"So we scrape and write grants and do what we can," said the principal.

Teachers noted that the student population was very stable, with little-to-no mobility. However, the principal mentioned that teacher turnover had been high across the district. Job openings remained unfilled, even during the summer. Both the principal and site coordinator attributed this issue to the high cost of living in their county. The principal's position, too, had changed during 2013-2014.

Teachers mentioned that the amount of parental involvement was dependent on both the individual family as well as on each individual teacher. Despite the professional parents' high interest in science, they often had schedules that made it difficult to attend their children's school day events. However, when teacher asked for parent volunteers, they would generally receive a good response.

Actually, the principal said, "[The school had] tons of parent involvement. We actually have too much. Parents always wanted to volunteer."

Another reason that the school was selected for inclusion in the cases studies was because the average percent correct was high for the fall 2011 PASS outcome, compared to other New Mexico schools in the study. Prior to LASER i3, teachers indicated that science education consisted mainly of textbooks and instructional time was shared with language arts. Moreover, grades K-3 received little or no science instruction.

Professional Development and Orientation

According to the site coordinator, all teachers received either the summer PD or the condensed training each year of the project, and they found the training helpful. Most teachers felt the training prepared them for the classroom experience by showing teachers how to prepare and set up an experiment, what to expect, and the "pitfalls."

The principal said, “Teachers have always said that the LASER i3 professional development was the best they had ever had on anything,” and added, “[I have] had some teachers really blossom doing [LASER i3]. Some were skeptical in beginning, but they love it.”

The site coordinator had stressed teacher attendance for training, and a few teachers concurred with the importance of attending the full training, acknowledging its pertinence for proper implementation. As one teacher said, “While the program is well-organized and what’s provided in kits is very easily usable by people strong in science, without the full training, teachers would have had a hard time making the learning experience successful for kids because the material are so in-depth.”

Still, teachers also had some general concerns about the summer training.

“A whole week was a lot to give up in the summer.”

Also, a new training location meant a long commute, which could impact teachers with families at home during the summer. Teachers also thought that the review might have been too time-consuming and suggested that, instead of the 2.5 days allotted for review, a quick discussion would be more appropriate and effective in retaining teacher buy-in and attention.

About the *Solids and Liquids* unit, some teachers said, “[We] understood it from the adult view, but were not trained in how to teach it [at the student level].”

Furthermore, teachers indicated that the training effectiveness was inconsistent across units. For example, those who received training on the *Sound* unit said that it was not as good as the training on *Butterflies.* While teachers who received training on the *Organisms* unit said “[It was] excellent and prepared [us] for what the kids will be doing.”

Preparation and Planning

A few teachers called the STC units "teacher friendly." Still, "extremely time-consuming" was how a couple of teachers described experiment preparation. However, one teacher used the setup for *Ecosystems* as an opportunity for community and parental involvement - volunteers helped the teacher prepare the classroom.

"I really needed help, and I think it's a wonderful way to involve the community."

Teachers also stated that 45 minutes was not enough time to complete a STC lesson. They thought that the volume of the STC content and activities that were expected to be covered in a day was a little overwhelming; one lesson did not equate to one day. One teacher added that she was "lucky" if she could finish the lesson in 1.5 hours.

On the other hand, some teachers acknowledged that the time constraint was less due to a problem with the STC curriculum, but rather, with other responsibilities happening during the day. They found it a challenge to accomplish everything by the end of the school day. Also, with required standards needing to be covered by the end of the year, one teacher remarked that 10-12 weeks was too long of a period to teach a single science unit.

By the third year of the project, the 4th grade teachers were concerned about using the STC units. Although they liked many aspects of the units, they felt they only covered a part of their current science standards, which presented a problem: teachers needed to cover all the standards because 4th grade students were assessed for science at the end of the school year (SBA). If they taught the three units with fidelity, it limited them in teaching the standards in time for the state assessment.

However, the 5th grade teachers thought that the STC units covered all the current standards. They chose to teach the units all year long, and believed that they taught the units

with “100% fidelity.” Also, while they agreed that set-up can be time consuming, they felt that every year of implementation made things easier; a lot of the preparation had been completed from the previous year and teachers had familiarized themselves with the STC units.

The site coordinator also reported that some teachers believed that the units were not age appropriate and would choose to skip a unit entirely or alter it. According to a second grade teacher, the level of reading and writing required for completion of the *Sound* unit was not age appropriate, neither in terms of amount nor format. Teachers predicted that the fidelity of their implementation of the *Sound* unit would not be as strong because of limitations with the unit. These limitations necessitated supplemental content instruction and adjustments to materials and protocol in order to accommodate the students’ developmental skills.

Teachers discussed how they modified the instruction for certain units. For example, one teacher indicated that she supplemented the STC unit on *Butterflies* with her own assessments, videos, and games. Also, a few teachers commented that they did not see differentiation built into the STC books or worksheets, so they set up their own rubrics for the journals to better address individual student learning styles.

Furthermore, teachers thought that the younger students (K-2) needed to focus on literacy more than science, which became difficult to do in 2013-2014 with three units. Specifically, teachers suggested waiting until the second semester to begin implementation for first graders, so that the beginning of the school year could be used to build reading and writing skills. Although kindergarten teachers would miss participating in LASER i3, first and second grade teachers stated that giving students the time to work on basic skill-building would help them better prepare for grade school.

"[The volume of inventory is] overwhelming at times, and it gets more so each year. Three kits next year will be hard—over 2,000 pounds."

According to the site coordinator, storing materials had also been a concern. Classrooms were too small to store the large containers inside, and the school building lacked general storage space. Along with storing standard STC materials, teachers also expressed difficulties in acquiring certain materials that were on the "needed but not supplied" list, such as size D batteries and plastic bottles.

Implementing LASER i3 in the Classroom

"They absolutely love it," said a 4th grade teacher.

The site coordinator added, "Kids absolutely love it, and because they love it, it puts extra pressure and desire on teachers to do it."

The principals, site coordinator, and teachers all indicated that the students had higher engagement and interest in science than before LASER i3, and that students were growing in their knowledge and application of organizational writing, scientific vocabulary, and the scientific method. Also, teachers noted that students were being exposed to science inquiry at much lower grade levels (K-3) than previously, which was preparing them for investigation and experimentation in the upper grade levels.

A few teachers also shared examples of how their students' vocabulary usage had expanded since LASER i3, and as one teacher said, "The vocabulary flying out is amazing, beautiful."

The site coordinator felt that many of the students with IEPs were benefiting from the LASER i3 program and were more participatory and excited during science. Teachers, too, briefly discussed the benefits they had observed among students with special needs. One teacher

noted that students "below grade level" did much better with inquiry-based learning, rather than reading from a text book. They would get immersed in the activities, which kept them interested for longer periods of time.

Teachers noted, "It's a chance for higher kids to do OK… to some degree, it brings the best out of low-end kids. They are doing deductions and giving surprising answers on their own… they love it. They love science."

According to teachers, the principal who was present at the start of the project had "pretty much mandated LASER i3 as the curriculum" for science. The site coordinator and the new principal from 2013-2014 said they believed that implementation fidelity was "pretty strong." When the principal asked the teachers to list the curriculum they use for each subject, almost all the teachers listed LASER i3 for science instruction.

Still, according to one 4th grade teacher who attended the district-level meetings in 2013-2014, the 4th grade science scores were "going down" on the state assessment.

Moving Forward

The principal was not sure about the future of LASER i3 in the school. He had not received any official word from the district, and although he wanted the PD to continue, he was unsure of how the district would fund it after the grant ended. The principal also mentioned PARCC assessments (Partnership for Assessment of Readiness for College and Careers) being fully adopted in the 2014-2015 school year, which could have an effect on LASER i3's future.

During the 2012-2013 case study interviews, the principal and site coordinator did not think the school would need much financial support to sustain LASER i3, because they felt the LANL (Los Alamos National Laboratories) Foundation would be supporting the school with storage, refurbishment of materials, and PD. LANL partnered with the school in 2012 and

offered to store the STC materials at a warehouse until they were needed for instruction. Materials would be sent to a centralized location within the county for storage and refurbishment. The principal and site coordinator indicated that LANL was doing this with 100 schools in the northern part of the region, which would include all districts in the study except for one.

The site coordinator reported mixed reviews among the teachers when they talked about the future implementation of LASER i3 at the school. Though some would say that they were glad to be continuing using STC units, others didn't want to do that. Similar statements were expressed in the teacher interviews; some teachers wanted to continue on with the units, while some were not as interested and struggled to have the necessary needed time.

During the 2013-2014 interviews, the principal commented, "Some of the teachers are really happy that they don't have to do LASER i3 anymore. [The] problem is that they're not doing much science at all."

Assuming that the school proceeded with the LASER i3 program, the site coordinator mentioned that they were looking forward to more flexibility with the units. After the grant ended, certain ones might be moved to different grade levels, and others might be used at different times of the year.

Conclusions

Most teachers were able to attend each year's PD sessions, and they found them helpful in preparing for implementation in the classroom. Although teachers might have to provide some additional materials (e.g., batteries or plastic bottles), everyone liked the STC units in that they were usually well-organized, teacher friendly, and provided most of the materials needed to teach a lesson. In particular, the 5th grade teachers loved their units, and they thought that the

materials were all that was needed to teach science throughout the year. As such, they felt that they taught the STC curriculum with very high fidelity.

According to the school staff, students loved the hands-on inquiry based approach and were more interested and engaged in science. Students had experienced further development in organizational writing, scientific vocabulary, as well as their knowledge of the scientific method, preparing them for learning science in upper grade-levels. Moreover, lower performing students were more excited about science and stayed interested in the lessons though the hands-on learning and exploration.

Because the classrooms were small and the school did not have a dedicated lab, storing the containers and materials was a concern. However, LANL provided a solution by planning to store the materials for the school in the upcoming years, partnering with the region in providing support for all the schools receiving STC units. They were possibly planning to provide future PD and refurbishment.

There were other concerns regarding LASER i3. Teachers had a few issues with the PD, including the commute to the training site and the length for subsequent review sessions. Even after three years, some teachers were still uncomfortable with their own knowledge of science. Teachers thought that some training sessions were not as effective as others, and in implementing the lessons, teachers occasionally felt that units or lessons had to be modified or skipped to better match the learning abilities of students.

Additionally, some teachers felt that preparation and set-up was too time-consuming. Ensuring that a lesson's content was covered in allotted time for science could be very challenging and further compounded by the need to cover mandated standards for end-of-year testing. Teachers were concerned that a new assessment would introduce new and additional

standards, which could further reduce the time for using the STC units, particularly if the standards were not integrated within the STC unit lessons.

NM Case Study E (NM-E)

A site visit of middle NM-E was done during the 2012-2013 school year, and then another during the 2013-2014 school year. Interviews were held with the site coordinator/science teacher (note: for this school, there was only one science teacher, who was also the site coordinator for the project) and principal. Some informal observations of classrooms were also done. Unless otherwise noted, any findings or assertions made in this report are based on those site visits and interviews.

Background

One reason that this school was selected for inclusion in the case studies was because it had a high proportion of students receiving free or reduced-price lunch. According to the principal, at least 90% of the students qualified for this service. The median household income for the community was almost $47,000 in 2010. Although that amount was slightly higher than then state median household income, the poverty rate was 23.6% for the area.

Another reason for selecting the school was that it had a substantial proportion of Native American students. The school was located between sandstone mesas in a very rural, small town of approximately 1800 people, near 19 different pueblos and four different reservations. The majority of students lived on these pueblos, which might be located up to an hour away from the school. Student mobility was reportedly low. The actual school population was only about 91 students with about 55% Native American and 34% Hispanic. Serving a largely bilingual population, a number of students were ESL, speaking the languages of their Native American tribes at home.

According to the principal, “Parents care deeply about their kids and are definitely involved if they have a program or a display.”

However, interaction with parents in curricular decisions tended to be more limited, possibly due to the lengthy commuting distances. While a few parents were employed by the local government, most commuted up to an hour away to one of two large cities. In general, parents tended to communicate more interest in reading and math, an emphasis which the principal suggested was likely carried over from the extensive historical focus on these subjects from *No Child Left Behind*.

Another reason that the school was selected for case study was because of low measurements in science knowledge and kit instruction. Specifically, students showed low gains in PASS scores from Fall 2011 to Spring 2012. Also, the average score for kit fidelity, as reported by teachers on their STC Unit Logs, were low.

The background education for students had an interesting dynamic and therefore should be mentioned. The local community had multiple elementary education options (public, charter, and pueblo school - BIA), and through the primary school years, pueblo children tended to stay home with their parents. Once students reached the 7th grade level, the school was the only middle school option in the community, and therefore, received an influx of Native American students from the pueblos. However, there was not a lot of student mobility; it was typical for the students within a cohort to move together from kindergarten through high school.

According to the site coordinator, science was not taught on the pueblo. Therefore, those students entered school with limited background knowledge of science.

Because the school served a small population, science was departmentalized with only one science teacher for all three grades (6-8). Science included some hands-on learning but without a notebook component. Science textbooks were reported as old and outdated.

Professional Development and Orientation

In 2012-2013, the science teacher joined the school because she was interested in working with inquiry-based science kits. Although she was new to kit-based instruction, as well as the LASER i3 project, she believed that her professional background would help her to teach the STC Curriculum. Her background included pre-medical training in the sciences, as well as teaching advanced college preparation courses in biology and physics using interactive notebook systems.

The principal was hopeful that the science teacher would continue working at the school, because, she said, "The district does not move teachers."

While the science teacher felt the condensed training session offered in November 2012 was "fun" and beneficial for knowing exactly how to teach the units in the classroom, after receiving her first full Smithsonian PD before the 2013-2014 school year she felt better prepared.

The principal added, "The full summer training is a rich experience."

Preparation and Planning

"It's easy for a principal to hold sacred time and resources for reading and math, and it's less pressing to hold those for science. As a school, we decided to go into the integrated science plan because of the LASER i3 structure," said the principal.

According to the principal, the school board was informed of the school's participation in LASER i3 and seemed positive about the strategic plan. However, due to the high-stakes testing attached to math and reading, those subjects received higher priority than science. The principal also indicated that, while the state has adopted the Common Core State Standards, she was uncertain about its alignment with the STC curriculum.

The science teacher thought that the units covered most of the New Mexico state standards. She chose to only teach science using the STC units and skip over those standards that were not covered by the units. Although it would be a couple of years before the PARCC assessment would be used at the school, the science teacher expressed confidence that usage of the STC Curriculum would improve state testing outcomes, believing this because it was well-aligned with the standards.

Both the principal and the science teacher were largely positive about the content and instructional approach for the STC Curriculum. The principal had noted "a lot of best practices embedded" in the program, including inquiry-based learning and the scientific note-booking process. The science teacher said that the STC teacher manuals provided "clear-cut" lessons and was most pleased about the application of the lesson content in the STC units. Also, whereas in the past, she had needed to spend a lot of money for science materials, all needed materials were provided in the STC units.

The principal also stated that the STC curriculum "seems very solid." She observed other teachers integrating the STC curriculum into their lessons. For example, the literacy teacher would use vocabulary provided by the science teacher's lesson.

However, lessons could still require extensive preparation. Because the science teacher thought that many of the students were "below grade level," some of the STC lessons took longer than expected.

"Even though the pacing guide states that this [STC] lesson might take one day, some days they only get through half. They can only handle half."

She thought that it was fairly typical for teachers to do five daily classroom preparations. As such, she felt that she could manage three different labs - one for each grade - with little

difficulty. She also noted that teachers at other schools had learned to stagger the preparation, and she suggested that it might be easier for her to set up the units if the classes were not held back-to-back.

Also, the science teacher said that she was using the *Planets* unit with all three grade levels during the 2012-2013 school year because some other units were incomplete. For example, several units were missing the teacher's manual, a few were missing the multimedia CD, and one unit was missing half of its inventory. While the materials were supposed to remain secure, she guessed that some might have disappeared during the first year (2011-2012) when she was not at the school.

Implementing LASER i3 in the Classroom

"I see learning occurring," said the principal.

The principal indicated that she observed high levels of student interest, particularly during the *Motion and Design* unit, and felt that it was a result from being involved with the STC units. Also, the science teacher said a few students showed excitement and wanted to try an experiment at home. Furthermore, about 12 of her female students asked to go to a science conference during the summer.

The principal felt that working in groups was very beneficial. She noted that in a group setting the "higher-level ability" students had the opportunity to help struggling students. Along with learning how to work in a group, students were able to ask higher-level questions and were being exposed to real life situations. She also heard about a special education student who was able to better verbalize what he was doing during a STC lesson.

Still, the science teacher dealt with a few challenges. Because students often lacked foundational knowledge, the science teacher needed to provide supplemental information beyond

the STC materials. It was also her impression that the STC curriculum might not be effective in preparing students to read textbooks and take tests for college. Moreover, when the science teacher was asked about at-risk students, she pointed out that her IEP and ELL often asked if they could "just take notes" during hands-on group work.

She stated, "Those kids do not like this. My special education kids find it too challenging."

Also, because of the large proportion of Native American students at the school, the principal and science teacher said that there were cultural challenges. They noted that Native American culture believes students are not meant to ask questions, but instead, should listen to the stories of an elder. This presented a problem when trying to use the inquiry-based method. Furthermore, for students who had been on the pueblo, classes were taught in their language and immersed in their culture, which may be very different from the expectations of a typical school.

The science teacher also thought that Native Americans struggled to see the value in education. In her opinion, many students were not interested in science because they did not understand the application. Her perception was that people from the pueblos valued community living; if something did not benefit the local community, they did not understand the value.

Moving Forward

Despite the cultural challenges, the principal believed that inquiry-based learning was beneficial to the students. In the last year of the project, the new principal indicated that she would like to continue with the program and favored supporting LASER i3 in the school's strategic plan. She suggested that SSEC and LANL should work together to secure more buy-in from superintendents, which could result in a more systemic support. In addition, she recommended that the state assign a regional educational coordinator (REC) to network schools

in rural regions and to provide infrastructure support (e.g., trainers, materials managers, and school resource officers).

In reviewing the school's progress toward meeting its goals, the principal was uncertain that community participation was at the desired level. However, the principal thought that parents had been enthusiastic about LASER i3 at the beginning and believed that they still continued to show an interest in the science program, especially parents associated with the Los Alamos Educational Foundation (LANL).

Regarding refurbishment and storage of STC materials, the principal surmised that they would be handled in-house and would be teacher-directed. She explained that her hesitation to give a more definite response regarding planning for long-term implementation came from knowing how budgets worked. She planned to have someone from the school reach out to the surrounding companies to see if they would be willing to fund the refurbishment of the units. She felt confident that they could find the funds because refurbishment was not as costly as buying new textbooks or funding an entire program.

However, she was not as sure about how the school would provide PD, saying, "To be honest with you, I have not thought that far yet."

In 2014-2015, the school would change from the New Mexico State Standards to the Next Gen Standards and the site coordinator hoped the new standards would align well with the STC units. She also reviewed PARCC, and was not sure about its assessment goals. Should there be gaps between the units and the emerging standards, she hoped that some guidance would be provided in how to address these gaps.

Conclusions

Lessons that were supposed last one day often covered two days. The science teacher felt that many students could not handle an entire lesson in just one day. However, the teacher at this school had good background knowledge in science, and she thought that the full-summer PD session was beneficial for preparing her to teach the units. She found that each unit provided necessary planning and materials for each lesson. She also thought that the lessons covered most of the state's standards at the time of the project, and chose to use the STC Curriculum and units throughout the school year.

Still, the cultural diversity, as well as the value placed on science education may have been different from most other schools, which caused some challenges. The science teacher felt that Native American students, who were typically homeschooled during the elementary grades, were not as interested in the experiments. Moreover, they were not as inclined to ask questions or partake in a discussion because of their cultural background, where students tended to not to ask adults questions.

The teacher also did not think that IEP/ELL students were interested in the experiments, but rather, felt more comfortable in taking notes from a text book or white board. Also, the teacher did not think that the STC units aided the students in reading or developing test-taking skills. Moreover, new standards were going to be added for the next year, and neither the principal nor the teacher was sure of how these might affect the future use of the STC curriculum.

There was a change in principals during the project, which provided more breadth to the "principal's perspective" of the project. They both seemed to appreciate the STC curriculum; the first principal specifically mentioned "best practices" within the units, as well as inquiry-based

learning and the use of scientific note-booking. The second principal focused more toward an appreciation for the use of group settings. Specifically, she felt that in a group setting, students could help each other in understanding concepts. Moreover, she thought that group settings led students toward seeing the concepts within real-world problems. Both principals felt that student interest in science was growing through the LASER i3 program.

In regard to funding, the first principal interviewed felt the LANL foundation would provide funding for continuing with the STC units. However, the new principal did not mention LANL for funding. Instead she thought that the school would could reach out to the community and ask for support for refurbishing the materials, but was unsure about how the school would provide future PD for the science teacher.

Returning to reasons that the school was selected for case studies, by Spring 2014, the school did experience slight increases in the PASS scores and STC unit log fidelity. However, the other reasons that the school was selected (high proportion of students receiving free or reduced-price lunch substantial proportion of Native American students) might better explain the lower measurements. Apparently, the cultural differences (e.g., perception of education and lack of background in science-learning; adult/teacher-driven learning), coupled with many students not starting school before 7th grade, may have introduced many challenges for teachers in trying to introduce a student-driven science curriculum.

Appendix C: Summary of Findings in North Carolina Case Study Schools

Regional Background

Though primarily rural, all four Phase 1 case study schools were from diversified communities across the state of North Carolina. The community populations ranged from 290 to 20,000 residents. The median household income was as low as $18K and as high as $57K, while the poverty rate ranged from about 27% to 45%.

Of the four schools, three were elementary schools and one, a middle school. The schools' student populations ranged from approximately 280 to 425 and the predominant ethnicity was Caucasian (57%-91%). Free and reduced-price lunch eligibility ranged from about 33% to 80% and all four schools were classified as Title I Schools. Three of the schools were located among lower socioeconomic communities, while one school was part of a more affluent community.

Prior to LASER i3 the schools had either out-of-date text books or no science textbooks. Professional development for science had either been provided many years earlier or was nonexistent. Reading and mathematics were the primary focus of most of these schools, especially at the elementary level, as they were considered the "building blocks" for most elementary students' education. Still, each school was provided non-STC kits by their district prior to and during the LASER i3 program.

In the summer of 2010, North Carolina adopted the Common Core standards which placed a focus on K-12 English, Language Arts, and Mathematics. Schools were expected to fully implement these new standards by 2012-2013. Also, another initiative, Read-to-Achieve, was adopted by North Carolina in July 2012 and applied to all schools in the 2013-2014 school

year. Although Read-to-Achieve was specifically targeted toward the third grade, it seemed to have an impact on the first, second, and forth grades as well.

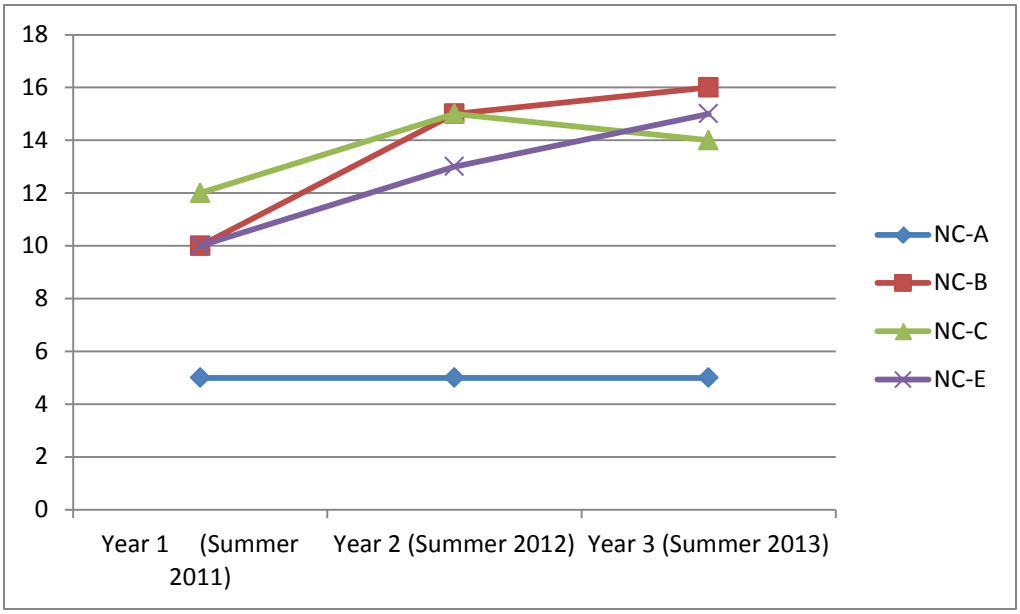
Selection for Case Studies

The four schools were selected for case studies for several reasons. Primarily, selection was based on higher occurrences of inquiry-based science classes in the earlier part of the project, as well high gains in performance for the students' PASS scores relative to other Phase 1 schools in the project. One school was also considered because of its high percentage of students qualifying for free and reduced-price lunch.

Professional Development and Orientation

All four schools attended the summer professional development (PD) offered by the Smithsonian and three of the four schools had the highest attendance by the third year of the project. The middle school (NC-A) had the same number (N = 5) of teachers attend each year. See Figure 14.

Figure 14: Professional Development Attendance for NC Case Study Schools



Many of the teachers who attended the Smithsonian's summer PD found it beneficial. The sessions provided in-depth content knowledge and understanding of science, which particularly helped teachers with little science background. Teachers were able to network together and learn how others used kits in their classrooms. Moreover, teachers were able to gain hands-on experience and a better perspective of how the units would be used in their classrooms.

Still, there were concerns about the content of the PD. One teacher with a science background found the PD "boring," while other teachers thought that the content might be too advanced to present and apply in an elementary classroom. Some suggested placing less emphasis on content (e.g., Level 2) and more time focused toward the preparation and teaching of units once they returned to their classrooms. One teacher mentioned that the pacing of the PD might have led to rushing the last part of the session. Teachers also suggested that the second year of PD could have been better utilized for time, instead of reviewing the materials from the previous year.

Teachers who did not attend the PD typically found the STC units difficult to understand and apply. Some teachers failed to attend the PD sessions because of the scheduling; specifically, because the session was offered at the beginning of their summer break, or because attendance was not mandatory. Others felt that a week was just too long for PD.

Planning and Preparation

With the exception of "needed but not supplied" items (e.g., bags of sand), teachers liked the kits because most everything needed to instruct an entire unit was provided (i.e., teacher's manual, lesson plans and time-line, and materials). Because many schools had out-of-date text books, or no textbooks, teachers also appreciated the reading passages. Moreover, the reading

passages helped with integrating science and reading, which was a high priority with the introduction of other initiatives, like Read-to-Achieve.

Although Read-to-Achieve was specifically targeted toward the third-grade, it had an impact on other elementary grades. Reading, which was already a focus at the elementary level, was becoming an even higher priority. Teachers wanted to ensure that students passed the third-grade end-of-grade (EOG) test. Students who didn't pass the assessment might be retained in the third grade or be required to attend a summer reading camp.

Many of the staff thought that the STC units did not always align well with the state standards. Teachers seemed hesitant to spend time on a lesson or unit that did not match the standards or specifically prepare the students for the end-of-year state assessment. This perspective might have led teachers to skip a lesson or postpone it-- or even the entire unit-- until after the state assessment had been administered. Some teachers also felt that some of the hands-on activities were not appropriate for the targeted grade-level or age of the students. For example, second grade teachers thought that the Sound unit was too advanced for their students. One school expressed the same concern regarding Land and Water for the third grade. In contrast, some teachers thought the Butterfly unit was too easy for second grade.

Another mandated initiative was the Common Core standards that began in summer 2010 and were expected to be fully implemented by 2012-2013. Teachers had to become familiar with these new standards, either developing new curricula or revising their current lesson plans to include these standards. Being responsible for teaching four or five subjects, elementary teachers, in particular, had to devote a good deal of time toward revising their classes for these mandated initiatives and sometimes felt the need to choose these over LASER i3, which could be viewed as a lower, non-mandated priority. With the addition of the new initiatives, available

time was diminished, and it appeared STC units were becoming less of a priority for many teachers.

Teachers also frequently mentioned how time consuming it was to plan, prepare, and set up a room to conduct an experiment. Some teachers said that they sometimes stayed at school until 7:00 PM in order to prepare a classroom for the next day's STC science lesson.

In cases where teachers had a teaching assistant, the assistant would typically be used to help set up the experiment, as well as help clean up the classroom following the lesson. The assistant might also help by providing assistance during the actual experiment. Though parent volunteers were used occasionally at one school, in general, parental involvement was low and/or diminishing at all of the schools.

Because some lessons might be taught at the same time during the semester, some teachers shared STC materials. Though some schools had no issues with sharing materials between teachers, other expressed challenges. For example, one teacher pointed out that she had to disassemble the cars in the Motion and Design unit, after another teacher's class, so that her students could build their own cars.

Some teachers were able to overcome this challenge by team teaching. For example, at one school, all of the students and teachers from one grade would meet together for one hour to conduct an experiment. The students would work in groups of four, while the teachers walked around and monitored the experiment and answered questions.

Teachers also had problems fitting the lessons into their allotted science instruction time of 45 minutes. In order to accommodate the time issue, teachers might extend the lesson over two days or perhaps skip some of the lessons in the unit to finish in time to move on to another standard or unit.

Teachers from higher grade levels (i.e., fifth and higher) appeared to have fewer issues with allocating time. This might be because of the number of subjects that each teacher was responsible for teaching was less (i.e., one or two) than the four or five subjects that the elementary teachers were expected to cover. Moreover, middle school grades might have a dedicated science teacher who also had a space to conduct experiments (e.g., a lab), as well as the time to prepare the room for an experiment.

Implementing LASER i3 in the Classroom

When the school principals, site coordinators, and teachers were asked about students' reactions to LASER, all were quick to say how much the students enjoyed working with the hands-on materials. Many of them felt that their students' interest in science was increased through this approach. Students were able to learn by using their hands, with real-world examples, and develop critical thinking skills. Instead of the traditional method of teachers presenting all the information upfront and then asking questions, students had to discover an answer through investigation. This was a new experience for many students, but an experience that teachers felt would better prepare them for high school science instruction.

Some students became so engaged with science that they were discussing and/or conducting the experiments at home with their families. Students who traditionally were "off-task" stayed more focused during the hands-on science experiments. Though many of them missed lessons due to a need to participate in special classes/interventions, teachers mentioned that the kits were very effective with Exceptional Children (EC). Reading a passage about science can be difficult for EC students, but they seemed to grasp science concepts better by working with the materials. EC students were also better able to work in a group setting and learn from other students, instead of just relying on instruction from the teacher.

On the other hand, group learning could present challenges. For instance, middle school teachers mentioned having some difficulty keeping their student on-task during group investigations; some students felt that being in a group was a good time to socialize with their classmates. One teacher suggested that being aware of which students were grouped together could be helpful in dealing with this issue, particularly with the middle school students.

Generally, teachers thought that students were retaining and establishing a good foundation of science knowledge by practicing, discussing, and writing about the experiments. Most teachers thought the science journals were a great component of the STC curriculum, particularly in how they could help integrate science with writing, as well as aid in the Read-to-Achieve initiative. However, some first grade and middle school teachers thought that the science journals were difficult to implement. While middle school students generally resisted writing at any length, first grade teachers thought that any length writing was a challenge for their students because many of them were just beginning to write. The teachers were hopeful that the students would eventually get accustomed to journaling.

The LASER i3 initiative had a couple of other perceived positive impacts. School staff mentioned that teacher and student interactions were increased by using the inquiry-based approach. Also, some principals felt that science instruction and assessment results had improved since the start of LASER i3.

Moving Forward

Overall, most schools appeared to want to continue using the STC kits after LASER i3, especially if their science score assessments showed improvement, but with some considerations. First, funding and support would need to be provided at the district level. At least a couple of schools had leadership changes at the principal or district level, and there was concern regarding

the necessary knowledge, experience, and support for continuing the use of the STC units. Many staff members hoped that providing positive feedback to their leadership would help gain the support and funding for material purchases and refurbishment.

However, even if there was support, there was concern over whether funding could be made available. Three of the schools were in poor, rural communities that might not be able to raise the funds from their communities or through corporate donations. In the meantime, some teachers were already planning to be frugal with supplies, enabling their reuse for future school years.

There was also a need for some flexibility in how and when to use the units. The staff might need to make minor revisions for grade levels, the time allocated for the units, utilize assistants or volunteers to help with setup, and ensure alignment with current standards and other mandated initiatives. Also, in order to avoid teachers returning to former methods, the units would need to be "teacher friendly," with some form of training made available to new teachers.

Selection for Case Studies - Summary

In revisiting the reasons for selecting the schools for case studies, relative to science instruction, there were some changes to consider. By 2013-2014, all of the case study schools showed some increase in the PASS measurements. However, two of the schools had a drop in observed inquiry-based science instruction (from Occasionally/Frequently to Rarely/Occasionally). This drop in observed practices might have been because of the challenges in available time, particularly due the introduction of other mandated initiatives (e.g., Common Core; Read-to-Achieve). However, despite this drop, the amount and quality of science that was being taught for students appeared to have a positive effect, as reflected by the PASS scores.

One school's observations of inquiry-based science increased from Not Observed/Rarely to Rarely/Occasionally, while the students' open-ended and performance-task assessment scores increased. Because many of the teachers from this school failed to participate in the first professional development session, this school likely had a slow start with inquiry-based instruction. However, as both teachers and students became more engaged in the LASER i3 materials, a positive impact appeared to be seen in other areas (e.g., assessment questions that required critical thinking) as well.

Phase 2 Schools Summary

In 2013-2014, two Phase 2 schools were selected for case studies. A primary reason why both schools were selected was because of high PASS scores. One of the schools was using non-STC science kits, which might help explain their high PASS scores. As with the Phase 1 schools, this school also had challenges with managing time for planning and preparation of experiments, as well as integrating science with other initiatives and standards.

The other school-- specifically selected because of high performance on the PASS' open-ended questions—did not use kits, but appeared to share teaching methods that aligned with some of the goals of the STC lessons. The principal felt that lessons should be project-driven and use real-world, applicable examples. Students from this school were encouraged to visualize, draw, and apply concepts, rather than master terminology and memorize right/wrong answers, which might have better prepared them for open-ended questions.

NC Case Study A (NC-A)

Two site visits of NC - A (a middle school, grades 5-8) were done during the 2012-13 and 2013-14 school years. Interviews were held with the principal (only in 2013-2014), assistant principal, site coordinator, and teachers (focus groups from each grade that participated in LASER i3). Informal observations were also conducted in classrooms. Unless otherwise noted, any findings or assertions made in this report are based on those site visits.

Background

One reason that this school was invited to be a part of the case study is because of the percentage of students receiving free or reduced-price lunch. It is located in a small community of approximately 3,300 with a median income of about $18,400 and a poverty rate of approximately 39.3%. The school's site coordinator believed that about 85% of the students lived in poverty. In 2012-2013, the school became a Response-to-Intervention (RTI) pilot and a Title I school. RTI involves implementing a new process/procedure and Title I provides the school with additional funds based on the percentage of children from low-income families.

Another reason that the school was selected for the case study was that the students' PASS scores showed the second-highest average gain from Fall 2011 to Spring 2012. Yet, observations of science classrooms showed low engagement in inquiry-based lessons.

Although LASER i3 was the only official science program in the school, the 5th grade had been using science kits for a number of years. Generally, science supplies were limited, and some funds might be provided by the district (e.g., $1,000 for the entire school) or through Title I funds. However, some supplies were purchased by individual teachers.

Professional Development and Orientation

Prior to LASER i3, professional development (PD) for science instruction was not normally offered by the district, and as preparations were made for the 2011-2012 school year, many of the science teachers were new hires or inexperienced with teaching science. Moreover, most of these teachers did not attend the SSEC summer professional development. In order to ensure better preparation for the following year, the school announced that it was mandatory for teachers to attend the PD; yet, many of them still did not attend the following summer session. According to the PD participation roster, attendance stayed the same from summer 2011 to summer 2013.

Believing that once a teacher actually experienced one unit lesson, it should be easy to use and implement future lessons, the site coordinator assumed most teachers would learn how to quickly use the units. However, in the third year of the program she attempted to dedicate time in her own schedule to provide in-house training/support for newer teachers.

"The kits are well put together," stated the site coordinator.

She added that teachers could probably "figure them out." However, by not participating in PD, some teachers were not prepared for the LASER i3 program. Particularly, new and/or inexperienced teachers found the units difficult to understand and apply without adequate training.

Those teachers who attended the PD found it to be a beneficial and a positive experience. The PD provided extensive content knowledge for teachers, as well as hands-on experience working with the STC units (though a couple of teachers would have preferred less background information and more time spent on the actual lessons and science journals). Because the trainer

was a full-time science teacher with many years of experience working with the STC units, teachers could appreciate the trainer's insightful knowledge.

As far as outside support was concerned, teachers felt that they received good support from the Smithsonian regional coordinator, as well as from their school administration. In most circumstances teachers felt they could get everything needed for implementing the units, and could work directly with the regional coordinator to answer questions or refurbish materials.

Planning and Preparation

Regarding the STC units, the teachers seemed pleased with content and quality. The site coordinator felt that the units were "ideal," making science instruction easier with the inclusion of a book, lesson plans/time-line, and materials for the teacher. The sharing of units between teachers was enabled by how classes were scheduled in middle school: for example, while one teacher taught science, another would teach math, and when they switched subjects, the unit would be available for the other teacher's use.

On the other hand, teachers frequently mentioned that preparation was time consuming; some teachers were staying at the school until 6:00 or 7:00 PM to prepare for the following day. Some teachers thought a teacher assistant was needed for preparation, while one teacher was helped by a parent volunteer.

Teachers thought that some STC units - e.g., *Force and Motion*, *Ecosystems*, and *Chemistry* - aligned very well with the current state standards, while others (e.g., *Micro Worlds*) did not. Most teachers said that they were not willing to teach something that did not prepare their students for the end-of-year state assessment. A couple of teachers remarked that they skipped over a few unit lessons that did not match the current standards, but if they had time at the end of the year, they might return to teaching the skipped lessons.

Implementing LASER i3 in the Classroom

At the beginning of the program, some teachers had challenges with keeping middle school students on-task during group investigations. However, over the course of the project, students appeared to focus-and-learn during labs, rather than using the time as a chance to "catch up" with friends.

The students loved working with the kits; they were excited and enjoyed hands-on learning. One teacher commented that students would not like it if the teachers tried to teach science in a different manner (e.g., with a video or worksheet).

"They are getting used to having the equipment and the things they need to do hands-on and cooperative learning," noted the site coordinator.

Furthermore, teachers saw students benefit from this type of learning by investigating, instead of just reading. For example, students learned about friction by observing the effects of friction on the distance their axel-driven vehicle traveled during the *Motion and Design* unit. Teachers felt working in a lab also better prepared the students for science in upper level grades (e.g., Biology, Chemistry).

The staff also believed that exceptional children (EC) and at-risk students benefited from the hands-on exploration and performed just as well as the other students during the experiments. They seemed to more fully grasp scientific concepts than they would from a traditional reading assignment.

"They're [EC students] the ones that need the visuals," said the site coordinator.

By not just focusing on reading and traditional assessments, teachers also felt that the units helped develop critical thinking skills. Very different from what most students had experienced in past science classes, each lesson provided the students with a problem that

needed to be solved, either on their own or in a group. In the past, students were provided all information up-front (e.g., via readings and lecture) and then asked to provide right/wrong answers on a worksheet, while now they would have to investigate, generate/test predictions, and then share their findings with the class.

One teacher noted that she had to be mindful of how to group students. She strategically grouped students who worked well together, as well as with EC students. Group collaboration helped both the higher- and lower-level students because the higher-level students could explain concepts to the lower-level students, and because of this peer-to-peer interaction, more learning occurred for everyone in the group.

It was mentioned several times during the school visit that the students did not seem to enjoy writing in the science journals. It was thought that, in time, students would get accustomed to journaling. To help students visualize how the science journals could have real-life applications, one teacher provided her students with various pictures of a scientist using a science journal.

One teacher voiced the concern, "Some of the kids aren't able to handle it."

This specific teacher said that, because students were not accustomed to inquiry-based, hands-on learning, they found the units too challenging. While some of the students loved investigation and experimentation, some of them would "shut down" and not want to participate. It should be noted that this particular teacher was new to the school and had not participated in the summer PD; therefore, these comments might be more of a reflection of the teacher's lack of preparation for using the units correctly.

Overall, the principal and assistant principal were very pleased with the program. The principal felt that the LASER i3 program had taken the school's science instruction to a whole

new level, and the experiential, hands-on instruction was engaging, which increased the interest level of the students.

"Science is not so boring."

The assistant principal continued to mention the school's state assessment science scores improving since the start of the program: "We were elated! I think the LASER program has a lot to do with that."

Reflecting about the nation's focus toward STEM, this initiative has helped show the importance of science education – the site coordinator remarked, "Now it's not all about math and literacy."

Moreover, realizing the benefits of the program through inquiry-based and hands-on learning, the site coordinator added, "This [program] *is* [school name]!"

Moving Forward

Not wanting to return to pre-LASER science teaching, the assistance principal eagerly looked forward to when hands-on units would be used for the entire year and proposed even incorporating the inquiry-based teaching method into other subjects.

"I think inquiry-based learning is the way to go."

If teachers are able to continue using the STC units, they plan to move a few of the units to other grade levels so it better fits the Common Core standards. Moreover, one teacher recommended that Carolina Biological and Smithsonian align the questions in the books with the Common Core Standards. Overall, the teachers wanted to continue teaching the units as long as there were funds for refurbishment. However, they did not seem to know what the school planned to continue or how they would get the money for more materials.

Though the assistant principal did not think that many community companies would help with funding STC units, both he and the site coordinator believed that the county would find a way to provide funding and resources. The site coordinator believed that, if necessary, the school would be able to find the funds. However, during the final planning institute session, county administrators considered how to provide funding so that the school would not have to be involved in seeking resources, as well as reviewed how other counties were handling this issue. In regards to training, the county plans to use the site coordinator for county-wide training, while experienced teachers will provide training of new hires for each school.

Conclusions

Implementation of any new initiative can involve challenges and resistance, especially in the first years. Beyond future funding and support for moving forward, there were a few issues mentioned in regard to students' acceptance of the program. Getting middle school students used to group collaborative work was a commonly mentioned challenge (e.g., some of them might tend to want to talk and "catch up with friends" instead of focus on the experiment). Students also did not enjoy working with the science journals. At least one teacher felt that the students might feel overwhelmed by the experiments.

In preparing for the lessons, it was noted that some units do not align well with Common Core standards. Generally, preparation was time-consuming and actual lessons took longer than expected. Some preparation issues may have be aggravated because many of the teachers did not attend the summer PD. Indeed, most of those teachers who *did* attend the PD stated that it was very helpful, and despite some misalignment for some material, some units actually did align well with Common Core standards.

Overall, when the staff considered science education from the students' viewpoint, they believed science instruction improved and became more interesting by allowing students to experience real world applications in the labs and experiments. Teachers also perceived that that the program strengthened students' critical thinking skills. Lastly, EC and at-risk students seemed to benefit from the experiential, hands-on learning by becoming more involved.

Once students became familiar with this learning style, they anticipated expectations and ended up preferring this type of learning. Moreover, state achievement science scores have risen since the start of LASER i3.

While those interviewed provided an overall, positive response to the LASER i3 program, after reviewing other data gathered at the school (e.g., online surveys, STC unit logs, and PD participation), it should be noted that there appeared to be little participation from the school. Yet, this did not necessarily affect how well the teachers implemented the actual program.

Returning to reasons that this school was selected for the case study (relatively high PASS scores, but low inquiry-based lessons observed), it is interesting to note that the PASS scores did continue to go up slightly into the next year, while observations of science inquiry-based methods rose from *Not Observed/Rarely* in the first two years, to *Rarely/Occasionally* into the third year. The school had a rough start in implementing the program at the beginning, possibly due to low participation in professional development, but seemed to have more teacher engagement by the third year.

NC Case Study B (NC-B)

A site visit of NC-B was done during the 2012-2013 school year and then again during the 2013-2014 school year. Interviews were held with the site coordinator, principal, and teachers (generally in the form of focus groups from each grade level that participated in LASER). Some informal observations of classrooms were also conducted. Unless otherwise noted, any findings or assertions made in this report are based on those site visits.

Background

One reason that NC-B was selected as a case study site was because it had a high proportion of students receiving free or reduced-price lunch (62.3%). Located in a small, rural community of about 20,000 residents, the median household income is a little over $30,000, while the poverty rate is 27.2% (about 10% higher than for the state of North Carolina). With a population that was considered low socioeconomic, it was the site coordinator's impression that most residents worked in retail (e.g., Walmart) or the fast food industry. The principal believed that many parents were unemployed or "drew disability." Parental support was minimal.

Those interviewed also believed that many children lived with relatives, where there could be 10 or more people living in the house, while some children might even be classified as homeless. Student transiency was reported as a problem. Specifically, the site coordinator said that it was not uncommon for a student to be out of school unexplainably for four or five weeks but then return. Student addresses and phone numbers were constantly changing.

Another reason that the school was selected as a case study site was because it had a high average score of science classrooms engaged in inquiry-based lessons (*Occasionally/Frequently*), as collected by site researchers during classroom observations conducted throughout the 2011-2012 school year.

A few years prior to LASER i3, the school was largely focused on science. With money provided by the district, the school had hired a science/lab teacher to teach science in all grades. However, the teaching position was no longer funded, following later changes in the administration and standards and less emphasis on science.

By the start of LASER i3, science had become tertiary to math and literacy. The fifth grade stressed science more than the other grades, which was possibly because students were assessed in science by the state at that level (e.g., EOG). For most grades, science instruction was self-contained and usually taught once a week or integrated into reading. A typical science class was a teacher-driven lecture with questions-and-answers and group reading. However, because most teachers did not believe that they had the content knowledge, many did not feel confident teaching science.

Some priority changes for science education were beginning in 2011: the district administrators started funding non-STC science kits for each school, which were rented for nine-week periods. However, there were some start-up issues. Whether or not teachers were finished using the kits, the kits had to be returned after the rental period. Because training or professional development was not provided with the kits, the school had to develop special training for its teachers. Despite these issues, it should be stressed that some staff had experience with science kits, and so, interview statements made about "science kits" could have included both LASER i3-provided units, as well as non-project-related kits.

Professional Development and Orientation

Most teachers were able to attend the three summer Professional Development (PD) sessions that were provided by the Smithsonian, and those who attended the sessions had mixed reviews. Some teachers felt overwhelmed following the first summer session. There were

teachers who thought that there was a lot of higher-level content covered, and there might be too big of a gap between what was taught and what could actually be applied in the classroom.

One first grade teacher said, "Give us a deeper understanding within a range … deeper knowledge the next grade-level up, like middle school, instead of going from first-grade to an adult. I can't imagine having a first-grader that deep in thought that they could ask a college-level question."

However, some teachers found it beneficial and helpful for understanding the units, as well as implementing them into a classroom. Moreover, the PD sessions enriched teachers' own understanding of science, which was a positive aspect for teachers who lacked a science background. The school principal also felt that the PD improved participating teachers' effectiveness and confidence in teaching science.

Planning and Preparation

There was some initial resistance to the new STC units. Teachers were slow to embrace the new instructional model, and several of them had a difficult time "letting go" of more traditional teaching methods. There were also concerns that students would not be able to follow hands-on instruction and science experiments.

Given that there were many other priorities to integrate into lesson plans (e.g., teacher common planning time, Common Core, Read-To-Achieve), teachers questioned how experiments and science could be fit into their daily planning and classroom schedule. During the second case study site visit, the principal pointed out that, due to a recently added state initiative (Read-to-Achieve), third grade teachers in particular would be much more focused on literacy and less on science in the third year of the LASER i3 program, which could affect how

well the teachers could implement the units. Because of the huge push for literacy through Read-to-Achieve, third grade did not have science as one of their objectives.

"Poor third grade!" said the site coordinator. "Everything's fallen by the wayside for them because of Read-to-Achieve, and it is very demanding, so their time is locked-up a lot."

Indeed, teachers thought that a lack of available time was one of the biggest obstacles with introducing the new science instruction. Besides the extra time spent preparing the lessons, teachers found that it took them closer to 45 to 60 minutes to cover the lesson, even though the recommended time for teaching a science lesson was about 30 minutes.

One teacher commented, "Two hours of prep work!"

During the first case study site visit, the principal remarked that the inquiry-based method aligned well with the Common Core standards. However, teachers did not think that the units were always aligned with those standards. For example, though *Solids and Liquid* was successfully taught in first grade, teachers understood that it is supposed to be covered in second grade. There was also concern that the material was not well-matched with the grade- and age-level of the students. For example, second grade teachers felt the *Sound* unit was too difficult for the students (e.g., asking students to construct and tie a guitar string), while the *Butterfly* unit was too simple and should be taught at the first grade level.

Teachers also wanted to plan for the sharing of units, but this, too, was difficult. For example, all first grade teachers might want to teach *Solids and Liquids* during the same part of the semester, but did not have enough materials across all teachers and classrooms; furthermore, when teaching the *Motion and Design* unit, it was a challenge to share because the teacher would have to disassemble the cars from the previous class. Finally, teachers wanted more materials so each student could individually investigate materials and results.

Implementing LASER i3 in the Classroom

Despite concerns that they had in preparing and planning the units, once the teachers saw the students' reaction to the experiments, they felt differently. Everyone at the school believed the students loved working with the kits.

"They loved it! They loved every minute of it!" said one first-grade teacher.

Students were very engaged and interested in learning science. They were more involved in class and excited to learn. Not only did teachers feel that science had become a favorite subject for most students, they observed that some students were going home and talking with parents about what they did and/or made in science class, and even working on their own science experiments at home.

A teacher said, "[Students] would rather do science than go outside on many days."

Specifically, students were able to investigate and participate in experiments on their own, which was new and exciting for them. Working with the materials and making something with their hands gave them a real world application of science concepts. Also, the staff felt that students were more often "on task." Moreover, teachers remarked that Exceptional Children (EC) and at-risk students were able to engage more in science, and they were benefiting from the hands-on activities. Instead of just having to read about science, often a difficult task for EC students, they were able to *experience* science through these activities. Also, because writing is a huge component of the state's literacy push (e.g., Read-to-Achieve), teachers felt the science journals were a great component of the STC units - science and writing could be integrated into the lessons.

At one point during a site visit, the principal remarked, "We had more students score at a level 4 in science than at any time since science testing was started in our county."

Students were gaining a better understanding of science. Both the site coordinator and principal mentioned that the school had the best 5th grade science achievement scores that they have ever had; they were above the state average and had a large gain from the previous year. They attributed some of that success to LASER i3.

The site coordinator said, "It's easier because they know the kits. They feel comfortable with them. They know that format, so they've kind of embraced it a little bit more this year."

Three years into the program, teachers were feeling more comfortable and confident with using the STC units. The use of the inquiry-based method continued to grow, and teachers wanted to continue to make it part of their weekly planning.

"What gets monitored gets taught," remarked the principal from the first site visit.

The principal had purposely visited classrooms to observe the STC units in use, and felt that the hand-on learning, along with the journaling, was becoming an important part of the science instruction. He also thought that there was an improvement in student engagement and teacher-student interaction. Though there was a change in leadership by the second site visit, that principal also felt that students' success and love for science could be attributed to the LASER i3 program.

Moving Forward

Most of the people at this school were very positive about the LASER i3 program and the use of science units and believed that inquiry-based method is the only way to teach science. However, they also had concerns about sustaining the program after the life of the grant. Because there was a new principal and vice principal (starting in 2013-2014) who did not have the initial experience with starting up LASER, the site coordinator expressed concerns that science, inquiry-based teaching, and science kits might no longer be as high a priority. The

expectations for teaching science might be further diminished when LASER i3 funding stopped. However, in both site visits, the principals believed the district would continue to refurbish the STC units, as well as support continued professional development.

Refurbishment funds might depend on teacher requests. However, all teachers might not want to continue with using STC units. Moreover, if refurbishing is based on individual requests, the site coordinator was concerned that the methods that each teacher used might not be compatible with the overall strategy for using the units. Also, the new principal was not sure how to proceed with providing adequate training for new hires. The site coordinator suggested that Condensed Kit Training might be an alternative, assuming that experienced teachers were willing to train new hires.

Coupled with the demand from other initiatives (e.g., Read-to-Achieve), there was still the chance that individual teacher approaches could be inconsistent. Nevertheless, the site coordinator had been stressing to teachers that inquiry-based instruction did not have to include a kit, but instead, this teaching style could be incorporated into all subjects.

Once the LASER i3 program was over, both the teachers and site coordinator were looking forward to more flexibility with the planning and use of the units; for example, better alignment to fit standards and grade/age-levels. Also, there were times (”downtime”) during a unit when a class would be waiting for something to happen over a week or two (e.g., a flower was growing or a butterfly had not yet emerged from the cocoon), and the teachers would like to be able to hand out science literature for students to read during “downtime.”

Conclusions

There were several challenges that the school experienced during its involvement with LASER i3. Generally speaking, there were limited resources. Having enough planning and

teaching time was an issue. Units take time to explain, and there were other initiatives and requirements that competed for available time. Having a sufficient number of kits was also a challenge, such as when an entire grade needed to cover the same topic. Moving forward, funding for units and professional development may be limited, which could be further compounded by future leadership unfamiliar with the program and focus turned away from inquiry-based learning and hands-on experiments.

Additionally, there were concerns that not all units are properly aligned with the correct grade levels or curriculum. For example, the *Solids and Liquids* unit is taught in the second grade, rather than the first. Also, some units did not align with the Common Core Standards. Our impression was that if unit lessons did not align with Common Core Standards, it was unlikely they would be used.

However, LASER i3 appears to have helped the school and students in many ways. The units seemed to help address the literary programs (e.g., the science journals helped with writing). Students were more engaged in science and liked the subject more; some were even "taking science home" (i.e., talking about it with parents and/or conducting experiments at home). EC and at-risk students appeared to be more engaged in science, and generally, students were on-task more often.

Professional development for implementing the units seemed to be very helpful for teachers. Inquiry-based teaching is occurring a lot more at the school, and the staff is finding it more effective. Moreover, the staff mentioned that fifth grade science scores had increased since the start of LASER i3.

There should be caution in attributing all the positive comments and test improvements to LASER i3. Apparently, the school had non-STC kits, prior to the LASER i3 initiative. The

positive attitude that staff had about kits may not be limited to just STC units, which might also explain why there was, initially, a high occurrence of observed inquiry-based lessons. Interestingly, though observed inquiry-based lessons were *Occasionally/Frequently* in 2011-2012, the frequency dropped to *Rarely/Occasionally* in 2012-2013 and 2013-2104. Even so, PASS achievement scores increased from 2011-2012 to 2013-2014 (e.g., the multiple-choice scores increased by nearly 25%). Therefore, the support and infrastructure (e.g., PD and kit refurbishment) made available by LASER i3 may still have enabled the school to focus more time and resources in making science inquiry-based learning a success for many students.

NC Case Study C (NC-C)

A site visit of NC-C was done during the 2012-2013 school year and again during the 2013-2014 school year. Interviews were held with the principal (only in 2012-2013), site coordinator, and teachers (generally, through focus groups from each grade level that participated in LASER i3). Some informal observations of classrooms were also conducted. Unless otherwise noted, any findings or assertions made in this report are based on those site visits.

Background

This school serves a small, secluded community of approximately, 9,800 residents. The site coordinator mentioned that the area was generally affluent, with pockets of lower socioeconomic families. The principal added that there were three gated communities, but outside of the gates, there were lower socioeconomic and/or some foster families. The foster families might be more transient, but overall, the school's student mobility is not high. The principal remarked that within the gated communities, "families with young children grow up, love school, and stay." The parent community was very involved and supportive of the school. Moreover, the PTA helped pay for materials when there was a shortage of funds.

The principal added, "PTA is very active, very supportive."

With a little less than 40% of the students qualifying for free or reduced-price lunch, the school was barely able to qualify for Title I status. Compared to a national median income of $53K, the median household income was about $56K for the community (the surrounding county's was $48K). The principal also mentioned that there was very low teacher turnover, outside of a few shifts between grade levels, and the loss of a teaching assistant due to budgetary constraints.

This school was selected for a cases study because the students had a high average percentage outcome for the Fall 2011 PASS.

When she starting working at the school, four years earlier, the principal said, "[Kits were] stacked here, there, everywhere!"

Prior to LASER i3, the school had been given non-STC kits, but the kits were not being widely utilized. The past use of science kits might have had some impact on teaching at the school, as one teacher mentioned, "[Teachers] tried inquiry, but it was not necessarily done all of the time." Teachers remarked that these non-STC kits were no longer being used because they had not been replenished in several years. Coupled with not having science text books, teachers felt that they were on their own in regard to science educational resources.

Professional Development and Orientation

The site coordinator spoke positively of the Smithsonian summer professional development (PD). Generally, teachers who attended the PD found it beneficial. LASER i3 was the first science PD that the teachers had received for some time. The teachers liked that the units were presented to them from the students' viewpoint. However, though the teachers were told that the training was mandatory, some did not attend the PD because the session was offered during the first week of their summer break.

A site coordinator said, "[No one] could tell them what to do."

Non-attending teachers read the manual to prepare for implementing the units. One teacher suggested that a webcast or an on-site, one-day training should have been offered for those who did not attend the initial week-long training session.

Besides thinking that a week was too long for the PD, many teachers said that the repeated information (i.e., review) from the first year PD was not necessary. To reduce the time

allocated for summer PD, one teacher suggested omitting the review and instead offering a separate training for those teachers who missed the previous year.

Teachers advised the principal that the PD could probably be condensed from one week to maybe 2 or 3 days. The principal thought that travel time could also help reduce the commitment if the PD was offered closer to their location. However, some teachers felt that this might result in PD being rushed or not well-paced; for example, fitting too much information at the beginning and then skipping or rushing material at the end.

There were a few comments about the relevance of the PD material and whether it really aligned with what they were supposed to be learning. A few teachers felt that some of the content was difficult to follow and understand, and a couple of teachers thought that the content was being taught at too high a level to use in their classrooms.

Preparation and Planning

Some teachers thought that not all of the units aligned well with the intended grade. For example, the third grade teachers thought that the *Matter* unit was ineffective because students had already received most of that subject's standard material in the first and second grade. Though the second grade teachers loved the *Butterfly* unit, they felt that the *Sound* unit was too advanced for their students' level and might be more appropriate for students in the fourth grade.

Along with Common Core, teachers were expected to follow a county pacing guide, which did not necessarily account for LASER i3 topics. By the second year of the program, teachers also noticed that the unit did not always align with Common Core standards and they were not comfortable teaching material that was not part of end-of-year testing. The principal also mentioned this concern and the need to ensure that units aligned with expected standards. However, she also wanted science instruction to be fun for students.

"I believe that things need to be aligned, but I believe that good instruction is good instruction. Whether or not it's aligned, it [inquiry based instruction and kits] is still good instruction, still good for kids."

Other initiatives also presented a challenge for planning and preparing to use the STC Curriculum. By Spring 2014, the site coordinator noted that reading had become the school's focus. Science was no longer taught as its own subject, but was now integrated with literacy.

"North Carolina Read-to-Achieve has just about eaten us alive."

The site coordinator also mentioned that Read-to-Achieve had to be aligned with M-Class (an additional state assessment for reading), along with end-of-grade (EOG) testing, and still include the LASER i3 project.

"The first year we were all 'gung-ho,' and because we've had so many other things thrown at us, it's just not…[the focus]."

Because of Read-to-Achieve, teachers also mentioned the shift to more a literacy-focused curriculum. It is now required that they teach reading for 90 minutes and grammar for 30 minutes a day, for a total of 2 hours of their classroom time.

"Reading is taking over."

This school was a Spanish Immersion School, which added more work (e.g. modules, PD) for each teacher, as well as featured Spanish-speaking teachers who moved through the grades with the students. Finally, students were sometimes required to be pulled from regular studies to attend special classes. However, because of district rules, students could not be removed from reading and math classes, but instead could be pulled from science, which could create a science learning gap between students.

Most grades were allotted 45 minutes a day for science or social studies - because after literacy, math and special classes, that was all the time remaining. This presented an issue for many of the teachers because, in their opinion, a unit lesson required more than 45 minutes.

Without an assistant or parent volunteer, preparation was very time-consuming. Teachers added that, because they could not spend months on one unit, they were choosing which components of a unit to teach. The principal stated that, because the STC units were very thorough, most teachers did not have the time to teach to their full extent.

"One unit in third grade, if they did it like they were supposed to, may take about a month and they don't have sometimes that amount of time to dedicate to it. Time is an issue."

Some units that the teachers specifically mentioned taking too many days to teach included *Plants, Circuits, and Solids & Liquids*. Each lesson from these units actually took about an hour to cover, yet, because there was not an hour per day allocated for science, lessons would need to be split over two days. For example, a 17-lesson unit might take 6 weeks to complete, which they believed was too long for one unit.

Trying to balance time for instructing science, teachers discussed the option of letting each grade decide what worked best for them. For a few units (e.g., *Organisms, Electric Circuits*), time constraints were addressed by combining some of the lessons. In fourth grade, teachers could team teach, which allowed for more science instruction time. This approach might include having one teacher covering reading/science, while another would teach social studies/math. In the second and third years of the program, first grade teachers also tried a teamwork approach, which appeared to make better use of time. This was accomplished by having three classes and their individual teachers and assistants all meeting in a science lab to cover the lesson together.

Implementing LASER i3 in the Classroom

The Principal felt that the units benefited all the students. She thought that, "when students can feel and touch something," they experienced deeper learning. Teachers remarked that students loved the STC lessons and experiments and enjoyed using their hands in lessons.

"They are actively engaged," said the site coordinator.

In addition, the second grade teachers observed EC students getting excited about having their own caterpillars and watching them grow. Overall, teachers thought that hands-on activities helped lower-achieving students make connections.

The principal said that the students were talking about the lessons, as well as doing experiments, at home. A couple of teachers mentioned that students were going home and talking about their science labs; one teacher received an email from a parent about how excited her child was about building a flashlight during science class.

Inquiry-based learning was not always well-received by students. Some teachers believed that many students were not comfortable finding their own answers because they were used to traditionally receiving all of the information and answers at the beginning of a lesson. Also, many students complained about having to write at length; specifically, the second grade teachers mentioned that students did not like using a journal.

Overall, through the LASER i3 hands-on materials, the site coordinator stated that the students were receiving a higher quality of instruction. The principal was also very pleased with the program; both she and the teachers believed that the STC units were easier to use than the earlier, non-STC kits. Particularly given the issues they had with not being able to replenish the non-STC kits, the teachers appreciated having all needed materials, which were well-organized and easy-to-follow.

Moving Forward

The principal definitely wanted to continue using inquiry-based learning, which she thought paired well with science instruction. However, teachers were not sure about the future of the STC units.

After the program ended, the site coordinator thought that the school might have more flexibility with the use of units and might even use them in other grades. However, she also thought that some of the older teachers might simply return to former methods, or as the second grade teachers implied, not utilize the materials because of time constraints. As had occasionally been done with the non-STC kits, some teachers thought that only the parts of units that would be beneficial for student learning might be used.

Some teachers were concerned about the replenishment of STC supplies after the LASER i3 grant. If STC materials were used, would they be replenished? The teachers believed it would be hard to maintain the units by themselves.

"Let's be honest, we're not going to go out and find those things (e.g., crabs, millipedes, D-cell batteries) ourselves."

However, other teachers would be diligent about saving and reusing materials in case they were not able to get the supplies replenished. The fourth grade teachers thought that they might still continue to use the units even if the materials were not replenished. For example, they would find a way to teach the *Animal* unit without the live specimens.

To proceed after LASER i3, both the site coordinator and principal believed that the support and funding would need to come from the county administration. There was some concern about whether or not there would be long-term commitment; though the current superintendent loved the LASER i3 program, the district was preparing to change over to a new

superintendent-- the third change in 5 years. However, there was some effort by the district administration to increase awareness for possibly securing future funding. For example, district administration showed a few completed science journals to the County Administration as a demonstration of what the students were doing during science through the LASER i3 program.

Conclusions

There were several challenges that seemed to impact the LASER i3 project at this school.

Generally, time constraints were a challenge, not only for planning and getting the materials prepared, but also finding the additional time to teach. Teachers also felt that that the professional development was too long and should be condensed.

Some teachers also did not like having the professional development offered during their summer break, which for some, led to just reading the manual instead. Moreover, some teachers thought that that the actual background content covered in professional development might be "over the heads" of students; it might be difficult to teach this higher-level content to their students. Also, teachers felt that the units were not always well-aligned with the targeted grade levels.

Furthermore, there were other initiatives that caused teachers to focus more of their classroom time on literacy and grammar and less time on science. Most teachers felt that they already had a full day of tasks to accomplish and were finding it difficult to fit in an STC lesson. Teachers were also expected to follow other standards; the county had introduced new pacing guides which did not address the LASER i3 initiative. There was also general concern about the science units not always aligning with the Common Core standards. Teachers needed to ensure that their focus was toward material for which they would be held accountable.

As one teacher said, "As much as we like the kits, we want to focus on what the kids are going to be tested on."

There was some general concern about available funding for when the project was completed, particularly for the refurbishing of materials. This was coupled with some uncertainly about support from future district leadership.

Despite the challenges, most teachers were able to implement the units. Some teachers thought the STC units were easier to implement than earlier, non-STC kits; moreover, having all necessary materials funded and available provided a better experience than the earlier kits did. Some teachers felt they would determine how to continue to teach a unit, even if materials were not refurbished. Having the science PD funded through the program was also a benefit and something that the teachers had not been offered for several years.

Overall, students typically liked working with the STC materials, and science instruction was improved when the students were learning with their hands. Hands-on activities may also have helped EC students. Students were more engaged with learning science, and some were even talking with their parents about science experiments at home.

In briefly considering the original reason that this school was selected (high multiple-choice average for the PASS in Fall 2011), it is interesting to see that the score increased about 7% by the Spring 2014 assessment. Despite the many challenges, this result suggests that the hands-on units are having a positive effect for students' science learning.

NC Case Study E (NC-E)

A site visit of NC-E was done during the 2012-2013 school year, and then during the 2013-2014 school year. Interviews were held with the principal (only in 2013-2014), site coordinator, and teachers (2^{nd}-5^{th} grade). Some informal observations of classrooms were also conducted during these visits. Unless otherwise noted, any findings or assertions made in this report are based on those site visits.

Background

Prior to the LASER i3 project, the overall teaching style at the school was more of a traditional, lecture-based approach. There were a few county-provided science kits dispersed throughout the grades, but little emphasis was placed on science as a subject. Additionally, there was very little professional development offered and the majority of the teachers did not have much background knowledge in science. Occasionally, inquiry-based instruction was practiced; however, this was not the norm. Typically, students were presented with science "facts" or read a passage about science from an out-of-date textbook, and then teachers provided a Q&A session.

After the first year of data collection (2011-2012), the school was selected for a case study because of the large gain in student scores (PASS assessment) from Fall 2011 (baseline) to Spring 2012 - among all the North Carolina schools participating in the study, this school had the largest gain in PASS scores. Moreover, the school had a high average observation score of science classrooms engaged in inquiry-based lessons during the first year. The evaluation team was interested in understanding why this rural, farming community was outperforming many of the large, urban schools and if these data outcomes might be a result of the LASER i3 program.

This school was located in a poor, rural community, which consisted mostly of farmland, small homes, and two-lane roads. The site coordinator's impression was that many of the residents in this area either worked on farms or were unemployed. According to the teachers, parent involvement was minimal. The median income was approximately $18,000 a year. Both the principal and site coordinator said that nearly all students would qualify for free or reduced-price lunch (estimated at about 80-90%), but parents were not always willing to apply for this service because they did not want to ask for assistance. Because nearly one-half of the families who could apply did not, the school received less funding than it could through Title I.

Despite the poor economic condition of the area, many people who started at the school stayed. For example, the case study interviews revealed that:

- many of the teaching staff started out as teaching assistants and then moved up to become a classroom teacher once they obtained their degree
- teacher turnover was minimal
- student transiency was reported as low and,
- the school's current principal attended this school as a child

Professional Development and Orientation

The principal, site coordinator, and most teachers thought the summer professional development provided by Smithsonian was very helpful. Overall participation was high for the school and rose each year. Teachers enjoyed the hands-on application provided during the professional development because it better prepared them for the actual classroom experience. For those teachers with little science background, the professional development increased their confidence in the subject by providing in-depth content knowledge.

One teacher said, “I thought I knew all about butterflies until I went to that training. I learned a lot.”

Other teachers mentioned the benefits of networking with teachers from other schools and learning how units were taught in different environments. However, one teacher, with a good background in science, found the PD “boring” and “repetitive.”

Planning and Preparation

Most teachers felt the set-up, implementation, and clean-up for each experiment was time-consuming. A couple of teachers said they would stay at school late to prepare for the experiment. Also, in their opinion, the unit lessons took longer than the 45 minutes of daily instructional time allocated to science; therefore, many teachers had to change the lesson in order to execute it in one class period. First grade teachers, who had an assistant for two hours a day, did not think it would be possible to continue using the units if their assistants were unable to help them. Other teachers had to share an assistant and found it difficult to prepare the experiment for the classroom. While parent volunteers were mentioned as a solution in one group of teachers, it was quickly dismissed as a probable option because parental involvement was low at the school.

One teacher remarked, “I can just see it becoming almost impossible to accomplish if they take away assistants next year.”

Teachers also felt some of the units took too many weeks to thoroughly cover. One teacher remarked that, although the program looked great in concept, building it into the actual classroom schedule was difficult. Because teachers felt it was important to cover all the curriculum standards before the end-of-year testing, there was not always enough time to fully teach an STC unit before needing to move on to the next standard. This might be an issue

because elementary teachers taught four-to-five subjects each day. The fifth grade teacher, who only taught two subjects (science and math), had a different perspective. In his experience with the STC units, time was not an issue. He pointed out that, because he was only responsible for teaching two subjects, he was able to spend more time on set-up and experiments.

Many of these issues and concerns voiced by the teachers may have stemmed from new initiatives being adopted at about the same time LASER i3 started. For example, Common Core's cross-curricular integration was introduced at about the same time that LASER i3 was introduced (2011-2012). Furthermore, in the 2013-2014 school-year, Read-to-Achieve was introduced, which was geared toward third grade literacy. These were new standards and initiatives that teachers were required to quickly adopt and integrate into their classroom, over and above the LASER i3 program.

"A lot of people aren't happy. There is a lot to do," stated the site coordinator.

Because of Read-To-Achieve, literacy became a bigger component of classroom instruction for all grades, which appeared to decrease the amount of time allocated for science. Fourth grade teachers thought that, because many of their students were reading below grade level, science should not take any focus away from literacy. While it was acknowledged that STC units had reading assignments that might be interesting to students, these components just were not enough to cover the amount of reading that the students needed.

One teacher said, "We really need to be bringing up the reading skill so they can read other science material to support what we're doing."

The site coordinator believed that, if the literacy component for the STC units was "a little more tied or developed," it would not be such a challenge to find time to implement. In other words, it needed to be more obvious to teachers how an STC unit combined a literacy

lesson along with a science lesson; apparently, the teachers were not always able to make those connections and integrate other subjects with the STC units.

In the last case study interview (Spring 2014), the site coordinator felt there was quite a bit of change happening for the teachers due to new initiatives and that time was an issue. Because of this change, she felt each teacher was going to need another year, if not more, to see where each unit could be integrated into the curriculum.

Implementing LASER i3 in the Classroom

One way teachers tried to address limited time was to team teach. For example, the first grade teachers would work together and teach all of their students at the same time - students would work in groups of four during an experiment while the teachers and their assistants would walk around and visit groups to assess learning and answer questions. This was the only way they felt they could teach the units efficiently and get everything accomplished.

Overall, the teachers liked the units and consistently pointed out that students got excited about using the kits. Also, in their opinion, the units were very clear and organized and provided teachers with all the needed resources to teach a standard.

"The kits are invaluable," said a third grade teacher.

According to the principal, the STC lessons were the "bright spot" of a teacher's day. The LASER i3 program helped teachers make a connection between science and literature and realize the importance of science in the curriculum.

While most teachers had at least one unit they enjoyed teaching (first grade - *Organisms*; second grade - *Butterflies*; third grade - C*hanges*), there was typically one unit each grade level found difficult to implement. Specifically, second grade teachers thought the *Sound* unit was too advanced for the grade level. While the unit matched the grade level standard, the teachers felt it

would be better suited for fourth grade due to having students manipulate string. There was a similar concern in third grade regarding *Land and Water* being too advanced for the students. Fourth grade teachers found the *Animal* unit overwhelming when implementing it for the first time.

Nevertheless, the principal and teachers felt the students thoroughly enjoyed the hands-on approach introduced by the units, as opposed to a lecture-based class. According to the site coordinator, science was becoming "a reward for kids." By practicing, discussing, and writing about the experiments, students retained more information about what they were learning and established a science knowledge foundation.

Other positives were that "off-task" students stayed more engaged in science class. Some students were even conducting their own experiments at home and discussing science with their parents. Moreover, a few teachers remarked on how involved their exceptional children (EC) were with the experiments. Through these experiments, the EC students were able to easily interact with other students, as well as use their hands to learn.

"This is something our EC and at-risk kids can do… actually excel with the experiments," said one teacher.

Unfortunately, those children are the ones who are often pulled during science to attend their EC classes.

Moving Forward

To get further support from the school district and community, the site coordinator felt it would be beneficial to share results to show how far the students had progressed since the start of the project. If the STC units were discontinued, she thought that teachers would be disappointed, but that the continued use depended on:

- student interest and performance at the junior high level (students picking those classes)
- available funds and resources
- whether the lessons were teacher-friendly and how well-aligned they were with students' needs and,
- how well the units aligned with other initiatives and subjects (e.g., Common Core and Read-To-Achieve).

The site coordinator also felt it was the principal, not the district level staff, who ultimately would decide if the units would be refurbished once the LASER i3 program ended. However, the principal thought it was unlikely that the program could be sustained, particularly for refurbishment. One possible source of funds might be donor and corporate sponsorship, but because of the school's limited proximity to big businesses, these sources were likely limited.

The principal also wanted to ensure STC units were age and grade appropriate, as well as aligned with the core standards before committing to any long-term commitment. Her biggest concern was how class size might impact time and resources. The class size cap had recently been increased from 18 to 25, which could impact the availability of tutors and teaching assistants in helping with implementation.

"I love them (STC units). I think they're wonderful. I think it's exactly what children need. I just wonder if it can be done with the integrity that it needs without enough people (to support it)," said the principal.

If teachers were able to continue using the units, they preferred to choose which of them best suited their classes and curriculum. The flexibility gained from no longer being a part of the study would provide the teachers with the opportunity to use them at their own discretion.

Conclusions

Teachers enjoyed having the STC units, as well as the resources and materials they provided. They found the professional development very helpful, particularly for those teachers with limited experience teaching science. After a couple years of being involved in the LASER i3 program, more teachers were beginning to feel comfortable with moving from a lecture-style of instruction to a hands-on, inquiry based learning strategy.

Students seemed to enjoy working with the kits. They were conducting experiments at home, excited about the science lessons, and seemed to retain more information from the lessons. Moreover, at-risk children seemed to be more engaged and involved when participating in science experiments. However, there was some concern that some units were not well-aligned with student ages. Some might either need to be refined or used with an older group.

Also, having sufficient time was a key challenge for implementing the STC units at the school. New state initiatives and requirements had limited the available time for introducing a new program. The message communicated was that it was already difficult enough for teachers to learn a new initiative and change their curriculum based on the new standards, and now they were also being asked to implement STC curriculum and units through inquiry-based learning, something which many of them were not familiar with or comfortable doing. Moreover, because of these new initiatives, a lot of the teacher's available time was going towards properly integrating these new initiatives into their classroom curriculum, and therefore, lessons were not always being taught to the fullest extent. The teachers voiced concern about teaching a unit halfheartedly, which is how some of them expressed feeling when having to devote more time toward other new initiatives.

Additionally, a key issue with moving forward, after LASER i3 was determining who was responsible for funding refurbishment and additional STC units. Generally, the school staff did not feel they had the funds. While the teachers hoped that the county would continue funding the non-STC kits that were in the school before LASER i3, teachers were unsure if that included the STC units. Despite an interest in the use of STC units, not being able to replenish and/or replace them, as well as provide continued professional development, might cause the school to return to earlier teaching practices.

In considering the reason that the school was selected for the case study (positive gains in science knowledge on the PASS assessment and a high number of observed science-inquiry lessons), it seems that a key element was that moving from the traditional lecture method was exciting for both the teachers and the students; therefore, students became more engaged in learning science and showed considerable improvement in PASS assessments.

However, the time to implement the units (further complicated by new state requests) might have compromised the amount of time that teachers had for inquiry-based learning. The observations of science inquiry-based methods dropped from *Occasionally/Frequently* in the first year, to *Rarely/Occasionally* into the last two years; also, another measurement of fidelity (use of unit logs) dropped from *To a Large Extent* in the first year to *Some Extent* into the last two years. Despite these findings, the student knowledge scores on the PASS assessment actually increased in 2013-2014, versus 2011-2012.

Appendix D: Summary of Findings in Non-Traditional Case Study Schools

Regional Background

Three Phase 1 schools were selected with unique educational approaches that differed from "traditional" schools. While each school used a different approach/program, these qualities tied the schools more closely to the inquiry-based approach used in the LASER i3 program. Because of this unique distinction, these schools were separated from a regional report to be a part of a non-traditional report. In order to protect the schools' anonymity, each school was given a pseudonym (Non-Traditional (NT) School A – C) and regional backgrounds or other regional identifiers were excluded from this report.

All three schools were Title I schools with a range of 57-95% of students receiving free or reduced-price lunch. The dominant ethnicity was Hispanic (53-95%) with White being the second most predominant ethnicity in two of the schools (21-25%) and African American the second most predominant race at one school (3%). All three schools had about 600 students; however, each school served different grade levels: PK-8, PK-6, and PK-5.

School A was unique in that it had a different mix of funding sources, which potentially allowed it to have more autonomy in directing and administering its school climate. The principal noted that the school had always used the inquiry-based teaching method because it reflected the school's overall approach for teaching students. However, the principal added, the school was still considered public, and it had to follow the same guidelines as other public schools, including curriculum and district level assessments.

School B was a hybrid of a Montessori approach and a traditional education approach. It had been transitioning from a traditional educational approach for about ten years. As teachers were trained in the Montessori approach each year, there were less traditional classrooms. The

principal thought that the inquiry-based learning emphasis of the STC Curriculum matched well with a Montessori-like approach. Teachers also confirmed that the STC Curriculum matched with the basic philosophy of the school's emerging educational model, which included "authentic teaching," "letting the children learn the concept," and implementing best practices in the classroom.

Finally, School C had adopted the international baccalaureate (IB) program – an international education program that is based in the trans-disciplinary and inquiry based approach. The principal supported the hands-on approach for science, and, along with the site coordinator, indicated that the school had worked toward aligning the science curriculum with science state assessments.

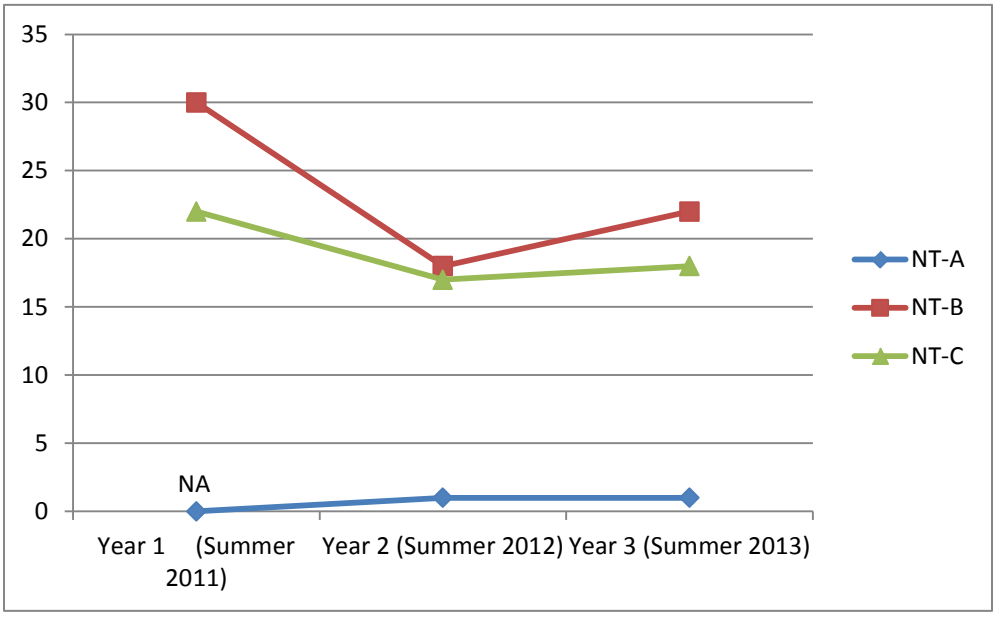
Selection for Case Studies

Besides their unique educational approaches, the three schools were selected as case study sites for other reasons. All of the schools were selected because they had a diverse and somewhat large at-risk student populations (i.e., Hispanic, English language learners, and students receiving free or reduced-price lunch). One school was also considered because of a high performance in all three areas of the PASS assessment, relative to other Phase 1 schools in the project.

Professional Development and Orientation

For Schools NT-B and C, the first professional development (PD) session (Summer 2011) had the greatest attendance by teachers. The next year's session attendance dropped by about 23% for one school and 40% for the other school. Teachers from School A were unable to attend the first year, while one teacher attended the remaining sessions (2012 and 2013). See Figure 15.

Figure 15: Professional Development Attendance for Non-Traditional Case Study Schools



Teachers reported that the PD was well-organized and beneficial. They felt it prepared them for using the STC units in the classroom and that not receiving the training would result in difficulty with using the units. Teachers who found the curriculum difficult also thought it was useful as well in deepening their content knowledge via the Level 2 training component.

For future training sessions, it was suggested that the attendance might be broadened to include other staff, including those who worked in instructing students (e.g., teaching assistants). Also, in order to improve attendance, it was suggested that training dates be announced far in advance. For teachers who were unable to attend PD, it was suggested that supplementary training be offered (e.g., training videos, sample notebooks), which could be reviewed by teachers throughout the school year for a better understanding of implementation.

Planning and Preparation

Teachers were positive in that they thought that the STC units provided them with sufficient materials for teaching a well-organized science lesson; many teachers added that they found the lessons plans were considerably structured and well-written, as well as well-organized.

However, two schools suggested that technology needed to be incorporated into the lessons. Specifically, one teacher suggested video clips, websites, and on-line lesson plans, while another suggested that PowerPoint presentations be utilized to reduce materials such as manuals and work sheets.

At least two schools mentioned issues with managing and storing materials. Managing materials could be time-consuming, especially for new site coordinators. One school's site coordinator found that some of the supplies were not very durable, which made it difficult to share materials between classrooms, as well as reuse the following year. Also, schools might not always have the capacity to store the containers in a centralized location, and teachers did not want to store them in their classrooms. Some elementary teachers requested a school lab as one way for solving the material storage problem.

Although a couple of teachers felt students struggled with subject integration, most of the staff interviewed thought that it was possible to integrate other subjects with the science lessons. One school mentioned integrating reading, writing, and math with their science lessons, while another school listed math and literacy. However, although the third school suggested that it was easy to integrate reading with the STC lesson, it was thought by the staff that math would be more difficult.

The teacher and principal from School A (a middle school) thought that having only one science teacher per grade made implementation easier. The teacher was not required to share materials across classrooms and was only responsible for preparing for one subject. Still, although the middle school teacher had one hour of planning time per day, she thought that the units required a lot of preparation time, though she found that it became easier as she became more familiar with the materials.

All of the schools mentioned available time as an issue. Teachers felt the STC unit lessons took longer to teach than anticipated and that the entire unit was lengthy. In order to finish on time, some teachers chose to shorten the lesson or not teach it as in-depth as planned. Teachers were also concerned about other initiatives, and one teacher chose to skip entire lessons that did not align with the curriculum.

Beyond struggling with the pressure to cover many subjects in a day (for elementary teachers), teachers found it difficult to balance expectations as well as prepare students for state assessments. Although these schools chose non-traditional teaching methods, they were still required to meet local and state requirements, as well as "juggle" initiatives that had been adopted as part of a non-traditional focus.

Still, teachers generally thought the STC curriculum paired well with the inquiry-based program(s) they were already using. One school mentioned that their instructional scope and sequence was clearly reflected in the STC curriculum.

Implementing LASER i3 in the Classroom

Staff from all three schools thought that students enjoyed working with the hands-on inquiry based materials and reported that students were more engaged, involved, interested, and "hands-on" during science. They also noted that students were excited about working in groups.

Principals and teachers also said that they liked the STC units. The leadership from School A and School B thought the lessons promoted positive outcomes for the student's science knowledge and assessment scores. The site coordinator at School C thought that the students' science state assessments scores were the highest because of the inquiry-based approach, and through expository reading, felt the STC units better prepared students for the state assessment.

Teachers also felt positively about the science notebooks, which added efficacy to the STC lessons and embedded writing within science. They reported that the notebooks helped students learn about organization. Students, including bilingual students, were using science vocabulary, as well as staying motivated and on-task during science.

However, there were some challenges with LASER i3. A first grade teacher thought the level of writing and knowledge of vocabulary was too high for her students. All of the non-traditional schools had a large bilingual student population, and the lower elementary students - still receiving some daily instruction in Spanish - struggled with reading everything in English. Bilingual teachers suggested providing some of the STC materials in Spanish as an option to use when students were struggling with language. Moreover, it was suggested that providing more materials in Spanish might initiate additional parental involvement with student homework.

Teachers at a two of the schools suggested that there should be more intermittent, formative assessments built into the STC unit, instead of one assessment at the end of each unit. Furthermore, School C's site coordinator felt that the last few lessons of each unit might be too specialized for teachers, who were dealing with time constraints in preparing students for end-of-year assessments.

Moving Forward

All three schools planned to use the units after LASER i3 ended. Principals seemed confident that continued PD and material refurbishment could be addressed through school funds or funds received from various grants. Although School B's principal supported using funds to continue the use of STC units, the site coordinator believed that district buy-in was needed.

All principals and site coordinators wanted to ensure the ability to align the STC curriculum with the district curriculum. School C planned to achieve alignment with help from

the district science curriculum department. School B's staff planned to select STC units, which best aligned with their curriculum and Montessori approach. A teacher at School B suggested that teachers meet as a group and discuss experiences implementing the units, which could help reinforce and sustain the use of the program.

The principal at School A felt it was important to provide STC training for at least a few teachers, which could help in reaching other, future teachers and keeping their interest and motivation. School C's site coordinator believed that funding was necessary in order to continue PD. In case the school could not afford PD, she suggested providing training videos for teachers; this approach could also be used if teachers were unable to attend a PD session.

Selection for Case Studies – Summary

All three schools were selected because of some non-traditional approach. Because inquiry-based learning was part of the school's curriculum, the LASER i3 program could be integrated, at least in part, within the schools. Although measurements of fidelity increased for one of the schools, the other two schools' fidelity did not necessarily increase during the course of the study. However, this could at least be partially due to available time and multiple initiatives/directives that were expected from the schools.

A couple of the schools were also selected because of PASS score performance. When reviewing the multiple-choice scores, results tended to increase from 2012 to 2014. With a non-traditional approach, which included inquiry-based learning, the inclusion of the LASER i3 program may have helped.

Non-Traditional Case Study A (NT-A)

A site visit of NT-A was done during the 2013-2014 school year. Interviews were held with the principal and one teacher. Some informal observations of classrooms were also conducted. Unless otherwise noted, any findings or assertions made in this report are based on those site visits and interviews.

Background

The school was located between a business area and an older, well-established middle class neighborhood. It was a Title I school that served about 600 K-8 students, with about 65% of the students qualifying for free or reduced-price lunch. Approximately 53% were Hispanic, and according to the principal, the school had about 41% of students classified as ESL.

One reason that the school was selected for inclusion in the case studies was because students performed well on the PASS assessment in Spring 2012 and Spring 2013. It should be noted that the school was not a part of the LASER i3 study until about midway into the 2011-2012 school year. As such, students were not administered the baseline PASS (Fall 2011), nor were staff invited to the Summer 2011 PD session.

Another reason that the school was selected for cases study was because it was a non-traditional public school. The school had a different mix of funding sources, which potentially allowed it to have more autonomy in directing and administering its school climate. However, according to the principal, the school was still considered public, and had to follow the same guidelines as other public schools, including curriculum and district level assessments.

Prior to LASER i3, according to the principal, the primary focus for elementary grades was “read, read, read.” However, students had the opportunity to be taught science every day. Especially at the elementary level, it was assumed that science had been integrated with other

subjects. At the middle-school level, science had generally been taught within its own time slot, every day.

Also, according to the principal, because the school was high-performing, he felt able to "do things my way because we have proven results."

The principal noted that the school had always used an inquiry-based teaching method because it reflected the school's overall approach for teaching students. Moreover, he felt that there was a lot of success in using the inquiry-based approach (i.e., the school was a high-performing school). The middle school also had two well-equipped labs for middle school science, and teachers had already been using science notebooks.

Professional Development and Orientation

Because the school was not a part of the study during the first summer PD session, the teachers were not able to attend that session. However, one teacher did attend the second- and third-year PD sessions, while the other science teacher never attended a session. Unfortunately, the teacher who had attended the PD training was not available for the case study interview. The teacher who was interviewed was, however, able to participate in condensed kit training; reportedly, she found that training "not very beneficial" because she thought it was just a review of the teacher's guide.

The teacher also pointed out that she was in her second year as science teacher. Because she did not believe that she had the background knowledge and skill set to teacher science, she was glad that she was able to start out using the STC units, which she felt provided her with everything she needed to teach science well.

Planning and Preparation

The principal said, “It’s a real strong program that allows students to dig deep into the curriculum.”

Because the school already used an inquiry-based teaching method, the principal felt the STC units paired well with the school’s program. Also, because there were only two science teachers in the middle school, he said that it had been easier to implement the units than it was in the elementary grades, where there were usually three teachers per grade.

The principal appreciated that the units could be used to not only teach science, but also to integrate math and reading as well. The teacher also thought the units incorporated a lot of reading and math, as well as writing.

The principal stated that the school used all three units with fidelity, and he wished that they had more. The teacher agreed, but added that she had to skip some lessons within a unit because she did not think the lessons always aligned with the school’s curriculum. The principal acknowledged that the STC units did not follow current grade-level curricula, although some grades aligned better than others.

When asked about whether or not she liked the STC units, the teacher said, “I do and I don’t. Like I said, the lessons that I like, I like. They’re good. I had to figure out what I should do and find the supplements for what I needed.”

The principal added, “With the accountability there is a lot of pressure in schools for time.”

The principal allocated one hour of planning time per day for teachers. Beyond the one hour each week that was scheduled for a PLC, he believed that they have enough time to prepare and accomplish most assigned tasks. Still, the teacher felt the STC lessons took a lot of

preparation time. Sometimes she had students help set up tables for experimentation. Because she was unfamiliar with the units, the first year was much more difficult, but she thought that for each year, the preparation and teaching became easier.

Implementing LASER i3 in the Classroom

The teacher said that the students loved working with the experiments. She believed that they were very engaged during science lessons. However, she suggested adding intermittent assessments for each unit, instead of a single assessment at the end of the unit.

She said, "[I wish] we could assess them as we go. It has that big assessment at the end, but something after three lessons or so."

The principal believed that, if teachers were allowed to use the STC units with fidelity, then the program would have a positive impact on student science knowledge and assessment scores. The principal also pointed out that the school had already been using science notebooks. He thought that this component of the STC units helped both teachers and students understand and visualize the lessons in which they were working.

He said, "[They are helping them] dig a little bit deeper with their notebook."

Moving Forward

The principal was already making budget plans for 2014-2015. He wanted to ensure that the school had the funds to refurbish the units, as well as provide additional materials for other teachers that were not included in the study (grades 1-5). He wanted every grade level to use units consistently and was confident that the school would implement the units for other grade levels, working to better align the district curriculum with the STC program. He also thought that the success for continuing with LASER i3 was to keep a few of the teachers trained and excited; in turn, this approach would help keep the other teachers interested.

"If we're going to use it, let's get it and buy it, if it's good for kids. And the STC kits are good for kids," he said.

Conclusions

Because the school was already using an inquiry-based approach, the principal felt the STC curriculum was a great addition. The science teacher felt the units provided her with everything needed to effectively teach a science lesson (i.e., materials, lesson plan, readers). Both the principal and teacher noted that the STC units were cross-curricular for reading, math, and writing.

Moreover, the principal appeared to believe in the LASER i3 program, thinking that over time, they would have a positive impact on students. The teacher and principal also saw that the students enjoyed working with the kits, keeping them more engrossed in science lessons.

However, there were a few issues with implementation. One of the two science teachers did not attend any of the Smithsonian PD sessions; although she did attend condensed kit training, she thought that it did not meet her needs. The teacher also felt that the time for preparing for experimentation took longer than she wanted.

Furthermore, both the principal and teacher felt the units did not always align with the current curriculum. Because of this problem, the teacher skipped over lessons that she thought were not relevant. The teacher also suggested that intermittent assessments be added into each unit's curriculum so she could assess her students throughout the unit, instead of just at the end.

One reason that the school was chosen was because it was a non-traditional public school. During interviews, it was pointed out that the school's approach to inquiry-based instruction aligned well with the STC units. Measurements of fidelity did support that the teachers were adopting the use of the STC units. Observations of inquiry-based science

instruction increased from *Not Observed/Rarely* in 2012 to *Rarely/Occasionally* in 2013 and 2014. Moreover, during the same times, STC Unit Logs showed an increase in fidelity from *To Some/Large Extent* to *To Large Extent/Yes or Completely*.

Another reason for case study selection was because of multiple-choice PASS assessment scores in Spring 2012 and 2013. Indeed, the raw scores increased by about 7% between these two test periods. However, by 2014, the scores dropped 16% from 2013, or about 10% from 2012's scores. So, even though the teachers appeared to be mostly using the STC lessons, actual student improvement was not measured on the PASS assessment. From information gathered during the brief interviews with the school principal and teacher, it is difficult to determine specific reasons for this decrease in scores. However, performance task scores increase by 11% from 2013 to 2014.

Non-Traditional Case Study B (NT-B)

A site visit of NT-B was done during the 2012-2013 school year, and then another during 2013-2014. Interviews were held with the site coordinator, principal, and teachers (generally, in the form of focus groups from each grade that participated in LASER i3). Some informal observations of classrooms were also done. Unless otherwise noted, any findings or assertions made in this report are based on those site visits and interviews.

Background

One reason that this school was selected for inclusion in the case studies was because it was had a high proportion of Hispanic students, as well as students with limited English proficiency. The school served a largely bilingual-- almost exclusively Hispanic-- community (over 95%). Students participated in a popular dual-language program. They were enrolled in the program by taking an oral assessment, and then their language of instruction was determined by the dominant language identified.

Administrative and community support was a key component of the dual-language program, and, according to the principal, parents wanted to attend the school because of this program. It included parent training as well as activities for parents to do with their children at home that supported what the teachers were doing in class.

"They [Parents] are more than willing to help. Our family reading night, science night, math night - they are there. Our reading was particularly well-attended," added the site coordinator.

The school was also selected because it had a high percentage (over 95%) of students receiving free or reduced-price lunch. The principal mentioned that about half of the students lived in apartments and mobility was fairly high, at roughly 29%.

Another reason that the school was selected for case study was that for students who took the summative assessment outcome (PASS) in Fall 2011, the average z-score gain in Spring 2012 was high. Science was taught daily and might have be an exception to the otherwise school-wide dual-language program. The principal explained how, in 2003, the scores on the state assessments for science highlighted the need for more work in science vocabulary. "Somewhere along the line," he said, "we felt it was important that science is taught in English. They need the vocabulary to do well in science, especially now with dual-coded questions on the test."

The principal had been at the school for 20 years. Also, according to the site coordinator, most teachers stayed at the school a long time. Although the school did hire six new teachers in 2013-2014, and the turnover appeared high, it was mostly due to several older teachers retiring.

Professional Development and Orientation

According to the site coordinator, all but two teachers were able to attend the 2011 summer training, and those two who were unable to attend participated in her condensed kit training. However, the PD attendance dropped by 40% in 2012, and was still about 26% less in 2013 when compared to the first year attendance number.

Because of schedule conflicts with the summer training, potentially a reason why some teachers did not attend the PD after the first year, the principal and site coordinator indicated that it would be beneficial to make the other types of training available for teachers. For example, teachers commented about how a training video or a sample notebook would be helpful for those teachers who were unable to attend the training, or switched to another grade level after the PD was offered. A couple teachers added that, without some kind of training, they would feel "lost."

Those who did attend PD stated that the training was well-organized and useful, as well as helpful for those teachers who found the curriculum difficult. Teachers also felt the trainings were very beneficial in showing them how to use the units in the classroom. As one teacher said, "It was very well-organized. We could do it just like we were taught."

Planning and Preparation

The site coordinator indicated that the LASER i3 program had the full support from the principal, as well as all teachers. She noted that there had been no problems with the implementation and that it had been possible for teachers to complete one unit every month, as long as they kept to a regular schedule. By 2013-2014, she added that every teacher would be using three units throughout the school year; during the site interview, she was even able to share a detailed calendar/schedule of when units were being taught at each grade level.

Teachers stated that sufficient materials were available for all classrooms to share, and lesson plans were well-structured, well-organized, and well-written. According to the site coordinator, the district scope and sequence were clearly reflected in the STC Curriculum. The principal also verified that there was no conflict with curricular alignment, saying, "As long as we get everything taught before the review period in fifth grade, we are fine."

Both the site coordinator and the principal indicated that they had worked toward aligning the science curriculum with the science state assessments. However, by Spring 2014, teachers mentioned a recent shift to math and reading at the school. Some teachers, however, felt that they could easily integrate reading with the units but thought math might be more difficult to integrate.

"It is easy to incorporate the reading into it. We've got the organizers and the writing. But as far as math-- I wasn't able to pull what I need to from math," said one teacher.

The principal also indicated that new teacher felt some stress with implementation. The site coordinator suggested that these new teachers, who were uncomfortable with science, could still teach science by following the script provided in each unit. "I train them to go through the script," she said, "Everything is there."

One teacher asked for a list of suggested books and other resources for supplementing. The site coordinator had to revise the units or occasionally supplement them, providing for unique student needs or to address standards, saying, "Sometimes I do take some liberties with the kit and insert some more comparative types of things."

"We are working with our students on technology," one teacher explained, "and we can't find anything to support us."

Most teachers wanted to see more technology incorporated into the STC unit lessons, believing it could enrich the curriculum and better develop vocabulary. It was suggested that various media be introduced, including short audio or video clips, websites, and on-line lesson plans.

Another challenge that teachers mentioned was having the space to teach the units. "We would like to have enough space to work on all this in one classroom. It takes a lot of space," said a teacher.

The site coordinator thought that many of the teachers loved the units, but did not want all the materials in their own classrooms, taking up a lot of space. She stated that the school was working to establish another lab area by using existing, unused space. She thought that this additional lab would make experiments easier for the teachers.

"We have to make miracles with time."

A few teachers spoke about time being an issue. They thought that some of the lessons took a while to teach, and they felt that the pacing was "not exactly kid-friendly." They did not believe that, to keep pace with the lessons, they could go in-depth and/or cover all of the information in the readers. Moreover, they felt pressure to ensure they covered all the other subjects for that a day. To address this issue, one teacher suggested having the ESL teacher cover the reading component of the unit lesson, while she focused on the hands-on/experiment component.

Implementing LASER i3 in the Classroom

"What I really like is that it gives the teachers opportunities to do the hands-on. It is important for teachers to have those options," said a teacher during the 2013 interview.

One teacher said, "The students are writing in their journals, about how they love science."

Everyone interviewed discussed how much the students liked working with the hands-on inquiry-based approach. The site coordinator thought that the units made science more exciting for students, and if asked, most students would say it was their favorite subject. She also thought that the teachers enjoyed using the units; beyond the students' response to the hands-on work, their state assessment science scores were consistently the highest subject. She also believed that the STC lessons prepared the students for the state assessment in every grade because of the expository reading component.

"It does help us a lot with reading and writing, spelling words for vocabulary. Writing their own sentences - growing, explaining, oral vocabulary," said a teacher during the 2014 interview.

One teacher thought that her students, including the bilingual students, were using more science vocabulary because of the STC curriculum. Specific to the LASER i3 experience for bilingual students, a teacher said, "We noticed that the bilingual students enjoy many things but are easily distracted. But this helps motivate the students. They like science. They are eager to ask questions. They are willing to even keep working at home, even when they have homework."

Still there were some challenges using the units with the bilingual population. Although she liked the STC units, a bilingual first grade teacher thought that many of her students struggled with trying to read everything in English. She suggested having some of the materials in Spanish as well as English so she had the option to use those materials for the students, if necessary. The teacher added, "Everything is ready, but I have to translate a lot for them, because they are in first grade. They are six year olds. Also, at the beginning of the year, a lot of them are not print literate. So for a lot of them, I have to do a lot of modeling and guide them."

Furthermore, to enable parents in helping with students' homework, one teacher suggested having more of the lessons provided in Spanish. If parents were unable to understand the material, there was a concern that they would stop helping.

Concerns were also raised regarding the developmental appropriateness for the amount of writing, which was asked of first graders at the beginning of the year. One teacher indicated that the amount, as well as the level of vocabulary required of students, was too high.

The pacing of the STC curriculum was also considered. The site coordinators thought, after the 10th or 11th lesson in a unit, the lessons "strayed" and were more specialized, at least from what most teachers were trying to teach their students, relative to end-of-year assessments and/or standards. Also, with regard to monitoring students' progress, a couple of teachers

suggested that the units needed formal assessments throughout the unit, instead of only at the end.

In summary, the site coordinator/science teacher appeared to be deeply engaged with the LASER i3 program. Overall, the site coordinator seemed to think very highly of the units; diligently ensuring her teachers were trained and using them with fidelity.

Moving Forward

Because the principal supported the hands-on approach for science, as well as was involved with its implementation, the site coordinator felt that the units would continue to be used after the LASER i3 project. The principal indicated that the school had enough funding from various grants to sustain the STC curriculum - supplying both professional development and required materials. However, direction from the district science curriculum department regarding the requirements and needs for the next unit would ensure the unit curriculum aligned with the school's curriculum.

Still, the site coordinator was concerned that the program might be difficult to sustain if training was no longer provided. She suggested that Smithsonian provide training videos for schools that might not be able to afford PD every summer. These videos might also benefit new teachers, as well as teachers that changed graded levels within the school.

Conclusions

Everyone who went to the summer PD sessions found them beneficial and helpful for learning how to implement the units and lessons in the classroom. They also commented about how the units provided them with all the necessary materials, and that within units, each lesson was well-organized and teacher-friendly. However, teachers who were unable to attend PD would have liked to have additional training via videos and sample notebooks. Also, although

teachers seemed to love the units, as well as the hands-on approach, some of the new teachers did not feel comfortable using them. The site coordinator addressed this concern about their confidence in using the units by providing them with training and support.

The LASER i3 program was fully supported by the principal. Moreover, the district scope and sequence worked well with the STC curriculum. Teachers felt that the STC curriculum was helping students with reading, writing, spelling, vocabulary, as well as increasing understanding of science concepts. The site coordinator and teachers noted that the students loved working with the hands-on component and writing in the science journals. Furthermore, the site coordinator thought that the units prepared the students for the state assessments; the students' science scores were the highest, when compared to their other scores.

Bilingual teachers felt their students were more engaged with science, and they were even willing to work on classwork at home. Since using the units, these teachers were also observing an increase in science vocabulary.

However, by 2013-2014, there was a shift in focus towards more reading and math. While the units were easy to implement during literacy lessons, math was not easy for the teachers to integrate with the STC lessons. The site coordinator supplemented on her own when she felt it was necessary. Some teachers suggested a list of additional resources, which could be used with each lesson, to supplement when needed.

Most teachers wanted more technology incorporated into the curriculum. While the school had been more frequently using technology with their students, the teachers thought that the units were inadequate in incorporating these technologies. Also, many of the teachers were dissatisfied with the amount of space required for the experiments, and wanted a dedicated lab for these activities.

Teachers thought that a lack of sufficient time was an issue. Some lessons took longer than expected, and as a result, teachers were not able to cover the lessons as in-depth as they wanted, or they saved time by not using the readers. To save time, the site coordinator suggested that the units end at lesson 10 or 11; she thought that the last few lessons of a unit were very in-depth, and perhaps were not necessary.

Some first grade teachers were concerned that the units were too advanced for their students, and there were other teachers that felt the vocabulary was a little too advanced for their students. Specifically, bilingual teachers wanted Spanish materials to be provided, particularly for students who were struggling with English. One of the bilingual teachers felt that, if the work was provided in Spanish, the parents might also be more willing to help the child with homework. Finally, in order to better monitor progress, teachers suggested that more assessments be incorporated into the units, instead of one assessment provided at the end.

Returning to why this school was selected for inclusion in the case studies-- a high gain in the summative PASS assessment from Fall 2011 to Spring 2012-- there were some interesting changes during the course of the project. The multiple-choice scores actually dropped about 6% from the Spring semesters 2012 to 2013. However, the scores increased about 21% in Spring 2014, which was a 16% increase from 2012

Non-Traditional Case Study C (NT-C)

A site visit of NT-C was done during the 2012-2013 school year, and then another during 2013-2014. Interviews were held with the site coordinator, principal, and teachers (generally, through focus groups from each grade that participated in LASER i3). Some informal observations of classrooms were also conducted. Unless otherwise noted, any findings or assertions made in this report are based on those site visits and interviews.

Background

One reason that this school was selected for inclusion in the case studies is because it was comprised of a substantial proportion of Hispanic students (a little over 60%) as well as students with limited English proficiency. The school served about 637 students, from PK – 6. It was also a Title I School, and over 57% of its students received free or reduced-price lunch.

Another reason that the school was selected for case study was because the average of the STC Unit Log scores (a measurement of fidelity) was low during Spring 2012. Moreover, the school was considered for case study because it had a non-traditional educational approach (Montessori).

The school had been transitioning away from a traditional educational approach for about ten years. Each year, there were less traditional classrooms as teachers were trained in the new educational model. For example, when the principal started at the school in 2008, there were five non-traditional classrooms; by 2014, there were 27. By the 2014-2015 school year, the school planned to have made a full transition.

Initially, the decision for the transition to a non-traditional education model was actively contested by the community, but by the time of the study, it was supported by an active and engaged community. Furthermore, although turnover had been low among non-traditional

teachers, it was high among traditional teachers; some teachers were not willing to spend the time required for the certification in becoming a Montessori teacher.

"People [teachers] attracted to the specialty program stay," the principal explained, while the demands of the credentialing process and of "the pressure cooker of public school" has left traditional teachers feeling "tired and feeling like their job is always in jeopardy."

According to the principal, the non-traditional educational approach they had been adopting over the past few years had a focus towards the inquiry-based approach. The approach also included science within the *Cultural Studies* discipline because of the influence of culture and geographical resources on scientific discovery and growth. FOSS kits had also been in use for several years, prior to the start of LASER i3, and a plan had been made to rotate the kits. However, the kits had since been "cannibalized."

In describing the district's efforts in building instructional capacity in science through professional development, the principal said, "The district put tons of money into science labs to ensure hands-on inquiry-based learning. Those were little blips on the radar. The district's done a lot around hands-on science. A lot of teachers rely on STEM Scopes virtual labs at other [specialized curricula] schools…[The school] did a lot around the 5E model, with a heavy emphasis on science. With [a community garden initiative], there were many outdoor gardens, an orchard, and a pond. It seemed to me that we needed to take advantage of these spaces."

Professional Development and Orientation

According to the principal, "Everyone who attended PD walked away saying it was amazing," and the site coordinator agreed.

Participating teachers commented that the PD was well-implemented. They noted that each PD session was set up nicely, well-paced, and prepared them for teaching the units. The

principal suggested that it might be a good idea to offer the PD for any staff who interacted with students, particularly, teacher assistants.

Teachers also commented that the PD was important to attend, and as one teacher who was unable to attend the summer session remarked, “It is difficult when you don’t go to the training of the kit you are teaching. The training is helpful, and it is hard to teach when you don’t have the training.”

Based on the PD participation roster, attendance was fairly consistent throughout all three years. However, so that teachers and school administrators could plan far ahead enough in advance, the principal suggested announcing the summer PD by April. One teacher suggested that a condensed training session might be helpful for those who could not attend a week-long PD. The principal also suggested offering supplementary training, a few months into implementation, for review and reinforcement, as well as to account for teacher turnover and teacher grade-level assignment changes.

Overall, teachers who participated in the Level 2 training spoke very highly of it. They felt it markedly deepened their knowledge of scientific concepts.

Specifically, one teacher said, “I would love to see more of the Level 2 for those teachers who are not comfortable with science. It went deeper into science for the adult learner so that they can teach.”

Planning and Preparation

A teacher noted, “It has always been hard to teach science because you didn’t have what you needed. That is what is so great about these kits. I wish every unit would have a kit.”

Teachers spoke positively about the STC program, particularly the provision of all needed materials. However, teachers indicated that the units did not always contain enough

materials for the entire classroom. Based on the comment below, the teacher may have not realized materials were to be shared among two students instead of each student having their own materials.

As one teacher pointed out, "The kit is designed for teams of 15. You may end up with the need for additional supplies, and you have to make do. The kits are meant to be 'everything is here,' but they aren't." Also, teachers found it inconvenient to share the kits with each other.

While some teachers wanted more materials, they also had issues with management and storage of the containers. The principal added, "With any kit, you have to have someone be accountable for maintaining the kit. It's not enough to just give it to one teacher and say, 'Here, you manage it.'"

By 2014, the site coordinator was managing the materials and found doing so very time-consuming. He felt that there was not enough storage capacity at the school for holding all of the containers and refurbished materials. The teachers agreed that storage was an issue. Teachers did not think that there was enough space to store large containers, whether in their classroom or a lab setting. Teachers also found the inventorying and organizing of materials to be challenging, and at times, had students help with materials management.

In regard to the materials, the site coordinator had some suggestions. He felt that, in order to be reused, some of the materials needed to be more durable. He also suggested that STC lesson PowerPoint presentations might be more useful in the classroom instead of books, particularly for "messy experiments."

The site coordinator also felt the lessons took longer than 30 minutes. It took about 90 minutes to cover all of the questions and "go deep." After teaching the lessons

in both circumstances (90-minute blocks and 30-minute classes), he felt that 90-minute blocks were ideal for an STC lesson.

Furthermore, the length of the entire unit was considered too long. The site coordinator thought that, if each unit could take two weeks to cover, it would be more feasible to get every unit taught at the depth expected of the teachers.

All teachers agreed that teaching one unit per year – aligned with the state assessment – would be doable, which would allow them to spend the necessary time for each lesson. However, they thought that teaching two or three units would not. One teacher said, "It is a lot of lessons. Time-wise, there is not enough time. We try to do a lesson one day and then another one another day."

It should be noted that this school had a number of district-level initiatives and directives to "juggle" along with LASER i3. These included, in part, a leadership development program, assessment-based, scaffold instruction, independent student reading practice, on-line, educational leadership PD, and additional PD for aligning curricula toward the specific state assessments. All of these initiatives needed to be integrated with the curriculum alignment from both a non-traditional (i.e., Montessori) and traditional educational approach.

The principal felt the current emphasis of the STC Curriculum toward inquiry-based learning matched well with a Montessori-like approach, which, as previously noted, the school had been integrating, grade-by-grade, over the previous few years. Teachers also confirmed that the STC Curriculum matched with the basic philosophies of the new educational model, which included "authentic teaching," "letting the children learn the concept," and implementing best practices in the classroom. However, a specific exception was how the new education model

was driven by each individual student, a technique not typically used in group settings, such as the STC curriculum required.

One teacher said, “There should be an integration of language arts and math. The STC is a good fit. I think that is the way those should be taught.”

The principal said, “With education in general, there is a heavy push on literacy and on ensuring that children are reading on grade level by the third grade. Science is an opportunity to integrate learning and is an opportunity that is often missed. This helps the kids build confidence. As we prepare them for the [state-based] test and language skills, other opportunities get overlooked in science because we get so focused on the numbers, the data. Feedback from teachers is that if you are expected to teach three STC units in one year, it concerns them that they will not have enough time to cover everything for the scope and [state assessments].”

Teachers generally supported the integration of math and literacy through science and commented about the usefulness of the STC Curriculum in addressing this approach. On the other hand, it was challenging for some teachers to teach language arts and math through science, and they thought that some students struggled with this approach, too. For instance, when teaching a science lesson that used the metric system, a teacher might have had to teach another, separate lesson about the metric system before proceeding with the remainder of the lesson. Moreover, there were concerns that teachers had to choose between integrating language arts and math, versus focusing towards end-of-year assessment tests. The principal acknowledged this concern and her support for teachers’ efforts to balance their students’ needs with the district’s demands.

"Teachers emphasize what the students will be tested on. The current state of education translates that every one of those tests means your job. That's the reality. The good teachers are so conscientious. They want their children to grow. They hesitate to veer in any way from the test," said the principal.

One teacher described how, in order to support adequate preparation for the state assessments, she modified her approach for using the STC units. She used the units, but integrated information that was more aligned with the state tests. A teacher said that they might also compress a couple of lessons in order to match the time required for teaching.

"There is massive tweaking [of the kits]," said a teacher.

One teacher added by saying, "I'm a big fan of the STC kits. I still have to cherry-pick. *Land and Water* would be a perfect fit for [the district], but we aren't doing it for the study. After the study, it will work better for the standards."

According to the site coordinator, it had been a struggle to implement LASER i3 in the Montessori-like classrooms because of the multiple grade approach (i.e., grades 1-3 combined; grade 4-6 combined), but reported that 100% of traditional teachers were doing it as planned. Moreover, according to the principal, some units might be more detailed than needed for the grade-level (e.g., 5th grade). The teachers also thought that there was a need to meet and discuss, as a team, how to develop LASER i3 to be more suitable for non-traditional, multi-grade classrooms.

Implementing LASER i3 in the Classroom

The principal said, "Without a doubt, I am entirely convinced that implementation of STC can make a difference."

The principal expressed her confidence in the potential of the STC Curriculum to promote positive outcomes for students at her school. The site coordinator added that students were more involved, interested, and hands-on with the units. Moreover, the coordinator noted that the students liked the use of color in the books. Teachers also thought that students were excited about the experiments, as well as sharing and working together in groups. Teachers also discussed the gains they had observed with student learning.

One teacher said, "Kids are weak in recognizing the variables - getting the kids to slow down, draw what you just did, and make connections…. In actuality, it was my first time in all my years of teaching, that all kids made the connection; they caught on."

A few teachers commented about their students' enjoyment of the STC science notebooks. The journals aided students in learning about organization, adding to the overall efficacy of the STC lessons, as well as embedding writing within science.

In summary, the site coordinator felt that the teachers enjoyed and were excited about the STC curriculum and units, but time and demands were challenges. The teachers, too, thought that the units were worth using, but again, they were concerned because of other initiatives and a lack of available time.

Moving Forward

For moving forward, one teacher suggested that teachers meet a few times throughout each semester and discuss their experiences with implementing the STC units in their classroom. She thought that this type of teacher collaboration would help enable implementation once refurbishment and PD was no longer offered.

However, "Anything that is not funded and mandated will not continue to happen," said one teacher.

Another teacher agreed that the future of the STC Curriculum - at any school - hinged on district buy-in. The principal added that principal buy-in was also necessary, not only for the STC Curriculum, but for science instruction.

"Principals need the background, training, commitment, and passion for science too, and to be willing to walk into a classroom and accept that science is messy and noisy. I think some of that's changing over time," said the principal.

The principal indicated that there was a system in place for storage and refurbishment of prior kit-based programs. She would support using school funds to similarly continue LASER i3. During the 2014 interview, the site coordinator stated that, in the future, the school would likely pick the best STC units that aligned with their curriculum and the Montessori model.

Conclusions

Everyone interviewed said that they liked the units and felt that the hands-on inquiry-based learning matched well with the educational approach of the school, but universally, they had challenges with time because of other priorities/initiatives, as well as problems aligning them to the curriculum. It appeared that all three units were not implemented at this school in the third year. It also seemed that a very high degree of self-customization was being done with units due to the non-traditional teaching method that this school had adopted.

However, teachers thought that the STC units were in-depth, well laid out, and provided all of the materials needed to implement a science lessons. Teachers also found the PD beneficial in preparing them to implement the units and providing them with a deeper science content knowledge.

Furthermore, everyone thought that the students enjoyed the experiments and working with their hands, and teachers appreciated the level of student engagement. It was believed that

students' science knowledge had increased since using the STC units. Many of the teachers also appreciated how the science journals exposed students to writing during science, as well as teaching the students organizational skills.

Generally, everyone supported the LASER i3 program and saw its potential; however, there were concerns about implementing the units in the manner that the grant had requested. Some of this concern could have been because of the multi grade-level classroom approach being used. For example, teachers did not have the opportunity to only teach the fifth grade unit to fifth graders, since classes consisted of students from three grade levels (4^{th}, 5^{th}, and 6^{th}).

Teachers also felt each STC lesson took more time than they had available. In some cases, it took some teachers an entire year to teach one unit. Time was also an issue for teachers in addressing all district-mandated initiatives, as well as preparing students for end-of-year state assessments. Alignment of the STC units with the school's new educational model and curriculum was a challenge for most teachers. In some cases, if a unit did not align well with standards, it did not get used.

The principal and teachers suggested that more PD opportunities should be offered during the school year for new teachers, teachers who changed grade levels, and teachers who may still have questions once they had started working with a unit. A couple of teachers also suggested that more technology be integrated into the STC lessons-- for example, PowerPoints instead of books/manuals.

Briefly returning to a reason that the school was selected for case studies, the STC Unit Log score continued to stay at about the same, low level. The multiple initiatives/directives that the school was expected to address during this time might have been why the units were not used with as much fidelity. However, it should be noted that the raw scores for the multiple-choice

section from the PASS increased over 11%, from Spring 2012 to Spring 2014. As the school moved toward a more non-traditional, inquiry-based approach, the units may have partially helped in supplementing the students' science education.

Appendix E: Cast Study Protocols

Phase 1 Case Study Protocol 2012-2013

The purpose of our visit today is to investigate LASER i3 implementation within the real-life context of your school, neighborhood, and district. We've done our homework and know quite a bit about the district and school from the data available on websites and the survey data we have collected, but we want to get "up close and personal" with you so we can really understand what it is like to try to make a new science program work here. We want to be able to tell your story in a way that helps inform science instruction in (Houston, NC, or NM) as well as in other districts and states.

I can personally assure you that neither your school nor anyone who works here will be identified in any reports that come from this work. I hope you will feel comfortable not just in answering the questions we ask but in providing any additional information that you think is important. *Are you also comfortable with us recording this interview just to be sure that we capture everything accurately?*

1) Let's just start with your "story" of your school in general. Tell us a bit about your school's characteristics—the community nearby, how your school fits within the district, the students who attend, about your teachers…
    - Administrator and teacher turnover/consistency
    - District culture/requirements and school initiatives/grants/competing resources
    - Student mobility and bussers, walkers, car riders
    - Previous science education program/emphasis, prior to LASER
    - School's state-level standing with NCLB/AYP
    - Parent involvement

2) So…you are halfway through the second year of LASER. Tell us your school's "story" of LASER at _____ school and your perception of how it's going overall.
    - Attrition of teachers and changes in principal leadership. Impact?
    - District culture and requirements. Impact?
    - Regional Coordinator support? Site coordinator support/involvement?
    - Site coordinator only: support from principal?
    - SPIs and strategic planning. Ability to implement? Usefulness?
    - Common Core and PARCC (NC/NM) fit with LASER? Next Gen standards?
    - Teacher professional development – Levels 1 and 2. Reactions? How many fully trained?
    - LASER materials—sufficient? Kit sharing? Cost to teachers?
    - Students' reactions to LASER…Interest? Learning?
    - Students' science achievement/state testing?
    - Specific thoughts about diverse and/or at-risk groups of students related to LASER?
    - Communication outside the school about LASER…Parents? Community?
    - Level of support for LASER inside/outside the school.

3) Finally…as you consider the duration of the LASER grant (the rest of this year and next) and beyond, what is your prediction for science education at your school?
    - Commitment of leadership and science teachers to inquiry-based learning?
    - Potential sea change involving other content areas?
    - Assessment of success?
    - Long term plans for PD and materials management (if kit use to be continued)?
    - Necessary district-level decisions to make long term implementation possible?
    - Community partnerships needed to maintain or develop?

Phase 1 Case Study Protocol (Revised) 2013-2014

Thank you for taking the time to meet with us today. The purpose of our visit today is to investigate science education within the real-life context of your school, neighborhood, and district, particularly related to your participation in the LASER i3 project. As you know, this is your third year of participation in LASER and our third year of data collection…so we know quite a bit about (HISD, NC, NM) and your school. This is our final opportunity to get "up close and personal" with you so we can really understand what it is like to try to make a new science program work here. We want to be able to tell your story in a way that helps inform science instruction in (Houston, NC, or NM) as well as in other districts and states.

I can personally assure you that neither your school nor anyone who works here will be identified in any reports that come from this work. I hope you will feel comfortable not just in answering the questions we ask but in providing any additional information that you think is important. *Are you also comfortable with us recording this interview just to be sure that we capture everything accurately?*

1) First, let's update the "story" of your school in general. What aspects of your school's characteristics are important for us to know to fully understand science instruction here—school's AYP standing, admin turnover, student mobility, science education, parental involvement (specifically listed below)…
    - Certain schools: has your AYP standing (changed and) impacted your instructional programs?
    - Administrator and teacher turnover/consistency
        - Certain locations: how has the administrative turnover impacted LASER implementation/participation?
    - District culture/requirements and school initiatives/grants/competing resources
    - FRL status and impact on instructional programs
    - Student mobility and bussers, walkers, car riders
        - Certain locations: tell us if you feel you've had a shift in the number of students on FRL or change in demographics
    - Previous science education program/emphasis, both prior to LASER and as LASER has been implemented.
    - School's state-level standing with NCLB/AYP
    - Parent involvement

2) So…you are a little more than halfway through the *third* year of the LASER project. Talk with us about how the implementation has gone.
    a. Overall level of implementation?
    - Attrition of teachers and changes in principal leadership. Impact?
    - District culture and requirements. Impact?
    - Regional Coordinator support? Site coordinator support/involvement?
    - Site coordinator only: support from principal?
    - SPIs/Strategic planning and Implementation Institutes. Ability to implement? Usefulness?
    - Common Core and PARCC (NC/NM)? Next Gen science standards?
    - Teacher professional development in science?
    - Teacher Quality of Science Instruction
        - Amount of time spent on science instruction
        - Science instructional materials—sufficient? Cost to teachers?
            - What type of science curriculum is in place? (CHOL, FOSS, Scott-Foresman, Rice program)
            - Certain locations: use of inquiry or kits in science instruction
    - Students' Interest in learning science?
        - Certain locations: ELL students? Hispanic students? Students with IEP?

- Students' science achievement/state testing?
    - What challenges (or successes) are there for LASER toward impacting science knowledge and/or achievement?
    - Has LASER impacted problem solving & written answers and/or hands-on exercises?
    - Certain locations: PASS achievement—growth or decline, or success with OE/PT?
    - Certain locations: PASS achievement—growth or decline, or success with OE/PT?
- Specific thoughts about diverse and/or at-risk groups of students related to LASER?
    - Has LASER had an impact on your school's high-risk population(s) in achievement or test-taking skills (e.g., literacy)?
    - Certain locations: ELL students? Hispanic students? IEP students?
- Do you think the PASS assessment is an accurate measure of students' science knowledge?
- Communication outside the school about Science Education…Parents? Community?
- Level of support for LASER/Science Education inside/outside the school.

3) Finally…what is your prediction of the impact of LASER for science education at your school?
    - Long term plans for PD and materials management (if kit use to be continued)?
    - Necessary district-level decisions to make long term implementation possible?
    - Community partnerships needed to maintain or develop?
    - Commitment of leadership and science teachers to inquiry-based learning?
    - Potential sea change involving other content areas?
    - Assessment of success?

Phase 2 Case Study Protocol 2013-2014

Thank you for taking the time to meet with us. The purpose of our visit today is to investigate science education within the real-life context of your school, neighborhood, and district. As a Phase 2 school in the LASER i3 project, your science teachers will have the opportunity to attend the Smithsonian Science Education Center's week-long professional development session this summer and will then receive an STC kit from Carolina Biological for implementation of an inquiry-based science unit approved by (HISD, NM, NC) for their grade level.

I can personally assure you that neither your school nor anyone who works here will be identified in any reports that come from this work. I hope you will feel comfortable not just in answering the questions we ask but in providing any additional information that you think is important. *Are you also comfortable with us recording this interview just to be sure that we capture everything accurately?*

1) Let's start with the "story" of your school in general. What aspects of your school's characteristics are important for us to know to fully understand science instruction---school's characteristics and any specific changes that have impacted teaching and learning—school's AYP standing, admin turnover, student mobility, science education, parental involvement (specifically listed below)…
    - Certain schools: has your AYP standing (changed and) impacted your instructional programs?
    - Administrator and teacher turnover/consistency
        - Certain locations: how has the administrative turnover impacted LASER implementation/participation?
    - District culture/requirements and school initiatives/grants/competing resources
    - FRL status and impact on instructional programs
    - Student mobility and bussers, walkers, car riders
        - Certain locations: tell us if you feel you've had a shift in the number of students on FRL or change in demographics
    - Previous science education program/emphasis, prior to LASER
    - School's state-level standing with NCLB/AYP
    - Parent involvement

2) So…(HISD, NC, NM) is a little more than halfway through the *third* year of the LASER project and your school is a Phase 2 school, delayed implementation. You have played an important role in the research study, and we need to know as much as we can about science education at your school.
    - Attrition of teachers and changes in principal leadership. Impact?
    - District culture and requirements. Impact?
    - Common Core and PARCC (NC/NM)? Next Gen standards?
    - Teacher professional development in science?
    - Teacher Quality of Science Instruction
        - Amount of time spent on science instruction
        - Science instructional materials—sufficient? Cost to teachers?
            - What type of science curriculum is in place? (CHOL, FOSS, Scott-Foresman, Rice program)
            - Certain locations: use of inquiry or kits in science instruction
    - Students' Interest in learning science?
        - Certain locations: ELL students? Hispanic students? Students with IEP?
    - Students' science achievement/state testing?
        - Certain locations: PASS achievement—growth or decline, or success with OE/PT?
    - Specific thoughts about diverse and/or at-risk groups of students related to LASER?
        - Do you feel your school's science instruction has impacted your high-risk populations in achievement or test-taking skills (e.g., literacy)?

    - Certain locations: ELL students? Hispanic students? IEP students?
- Do you think the PASS assessment is an accurate measure of students' science knowledge?
- Communication outside the school about Science Education…Parents? Community?
- Level of support for Science Education inside/outside the school.

3) What are your thoughts about professional development this coming summer and the LASER kits next school year?
    - What do you know about the LASER model?
    - What are teachers' perceptions regarding this summer's PD?
    - How do you envision the STC unit being received by teachers and students?

4) Finally…what is your prediction of the impact of LASER for science education at your school?
    - Long term plans for PD and materials management (if kit use to be continued)?
    - Necessary district-level decisions to make long term implementation possible?
    - Community partnerships needed to maintain or develop?
    - Commitment of leadership and science teachers to inquiry-based learning?
    - Potential sea change involving other content areas?

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