Final Evaluation Report for the Helios STEM School Pilot

August 31, 2016

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Executive Summary

The STEM Education Evaluation Center at TERC was contracted to conduct a three-year evaluation of the Helios STEM School Pilot (HSSP), in collaboration with Science Foundation Arizona's Evaluation Compliance Officer. Results of our mixed methods study have been shared with the Helios Foundation via occasional updates and annual reports. Through these, we described STEM immersion efforts and interim teacher and student outcomes across the seven participating Sites: Alhambra, Altar Valley, Bagdad, Congress, Killip, Salt River, and Yuma. In this final report, we return to the overarching evaluation goals established for the project, providing evidence of:

- ❖ Program growth and lessons learned about STEM immersion;
- ❖ Overall outcomes in teacher and student STEM attitudes;
- ❖ Overall gains in student STEM learning; and
- ❖ Promising practices, future plans, and challenges related to HSSP sustainability

At the outset, all Sites established a baseline level of STEM immersion. Then, they designed strategic plans to improve their STEM education programs in a systematic fashion, with action steps to address interrelated strands of work: leadership; teaching; learning; evaluating; budgeting; and sustaining. End of project evidence from each Site's own evaluation, verified by external data, indicate that ***all Sites increased their level of STEM immersion.*** This was accomplished by using a structured yet adaptable HSSP process that included targeted support to broaden, deepen, and improve STEM offerings.

Programmatic improvements influenced teacher and student growth. Descriptive T-STEM survey data indicated that participating teachers (who were involved for varying amounts of time) developed more positive attitudes in all STEM areas. More compelling were the results from additional and more rigorous analyses of teachers who participated in the entire project. These showed ***statistically significant positive changes in attitude on the science, technology use, student engagement, and career awareness*** subscales.

There were ***no significant changes in student attitudes*** as measured by the S-STEM survey. Descriptive data indicated that students had more positive attitudes toward engineering/technology as compared with math and science, that students in older grades reported lower levels of interest and confidence than elementary students, and that gender differences in male and female student attitudes (with males having higher levels of interest) did not change during the project. Unfortunately, we don't have full confidence in these findings, as survey administration and data collection issues interfered with this aspect of the study. We provide further detail of challenges as well as recommendations within this report.

Although students' long-held beliefs and attitudes are often slowest to change, we typically expect changes in classroom instruction to impact student learning. This turned out to be the case. Across all participating Sites this year, ***the combined average gain in mathematics scores and in science scores were statistically significant*** on Galileo assessments. The results mirror those of last year and suggest that students made steady progress, expanding their math and science knowledge and skills during years 2 and 3 of the project. Moreover, our analysis of individual Site data identified ***statistically significant gains in math and science in at least two grade levels per Site,*** **with** ***most Sites achieving significant gains for students in all or almost all grade levels.***

Lastly, our data suggest that much of the work of the HSSP is likely to continue after the grant ends. ***Many of the Sites carefully and systematically transitioned from having grant funded project activities to embedding them in normal educational practice within their school system***. Evidence of funding through school budgets and new grants will enable key STEM programs to continue. In addition, recent and planned expansion of STEM activities, structures that allow staff to maintain and upgrade STEM resources, and STEM awareness and cultural shifts within the schools help to ensure sustainability. At the same time, individual Sites must be vigilant in carrying out these plans, for there is also ***evidence of barriers to sustainability***. If addressed, the notable progress of HSSP Sites may be sustained, and these strong STEM educational communities will thrive well into the future.

Program Growth and Lessons Learned about STEM Immersion

Prior evaluation reports and presentations have described STEM integration within Sites. In this final year, we share overarching evidence of program growth as well as barriers to STEM immersion. TERC collected and analyzed data from Site observation visits, interviews, strategic and sustainability plans, and annual review meetings and documents. These data were triangulated with interview data from SFAz Technical Advisors, and, whenever possible, with artifacts from teachers (e.g., curriculum plans); students (e.g., class work samples); and Sites (e.g., meeting notes). From these data, we offer lessons learned, and, where appropriate, examples from the Sites.

THE HSSP PROCESS SUPPORTED SITE PROGRESS FROM PROPOSAL DEVELOPMENT THROUGH FINAL REPORTING

- All Sites followed a carefully staged and supported process of STEM implementation that included:
  - establishing a baseline of STEM immersion via the STEM Immersion Guide and online-self assessments, and identifying an end goal/level within the Guide;
  - developing and revising annual strategic plans that operationalized growth goals;
  - creating a sustainability plan grounded in the realities of each Site's context and evidence of their progress during the first two years of the grant;
  - receiving funds tied to goals, strategic plans, and achievement of milestones.

- Essential support was provided by SFAz, helping Sites to remain faithful to the process. Collaborative work with SFAz required Sites to: address a number of competing factors across the system (e.g., budget limitations, teaching needs, community involvement); prioritize specific activities aimed at building capacity and reducing barriers; proactively address problems in one area that might negatively impact another; and utilize success in one aspect of implementation to strengthen another area.

Although Site contexts and needs varied greatly, a structured process that included targeted and consistent support enabled *all Sites* to increase the amount and quality of STEM educational experiences within their schools/district. The cumulative outcome was a higher level of STEM immersion that is likely to be sustained in the coming years.

STEM GROWTH WAS PROMOTED BY ALLOWING FOR SITE-SPECIFIC DESIGNS AND FOR CHANGES TO STRATEGIC PLANS IN RESPONSE TO SHIFTS IN SCHOOL/DISTRICT PRIORITIES, LEADERSHIP, AND PROGRESS

- Sites required different types of enhancements to infrastructure, equipment, and resources prior to the integration of teaching, learning, and community activities. Site locations, internal resources, and school/community expertise varied greatly. Ensuring that each Site identified and then established the foundation upon which to build programs was essential. Some examples include:

  - Action Labs (Paxton-Patterson engineering modules) were purchased by Alhambra, Bagdad, and Altar Valley;
  - Increased bandwidth and improved technology systems were acquired by Congress;
  - iPads were purchased in Yuma to improve technology use in classrooms;
  - Robotics equipment was purchased by Salt River to expand computer science;
  - Improved software was purchased by most Sites.

- Progress was accelerated when Sites took advantage of existing STEM resources and plans. In addition, time and money were saved and then redirected to other aspects of the initiative. For example:
  - Yuma had experience with developing science cadres via their DoDEA grant. The Special Projects Coordinator built on that knowledge when creating cadres and professional development sessions for HSSP schools in her district.
  - Killip was informed by a long-standing goal of becoming a STEM Academy. With this in mind, they strategically designed STEM professional development and student learning activities that would allow them to fulfill the requirements for this designation.
  - Altar Valley owned FOSS kits that were seldom used prior to the grant. After some false starts, professional development was restructured. All teachers got involved and had hands-on experiences with the kits, enabling them to understand key concepts and to develop instructional strategies.
  - In Bagdad, Helios funding allowed for existing CTE course improvements and an expansion of offerings so that all students could take at least one.
  - Science kits and materials were housed in a central location in Salt River, making it difficult for teachers to find and use them. Together, the STEM Coordinator and Technical Advisor organized these resources and brought them to teachers' classrooms, increasing ease of access and use.

- SFAz supported HSSP Site leaders in making changes that were responsive to the school/district context as well as changes in leadership. For instance:
  - In Altar Valley and Bagdad new superintendents reassessed plans for a greenhouse and garden respectively, concluding that these would not have broad enough impact. As a result, (and with guidance from Alhambra), both were allowed to revise strategic goals and move funds to purchase Action Labs.

KEY SUPPORTS WITHIN SITES AND FROM SCIENCE FOUNDATION ARIZONA INCREASED EFFICACY AND ENABLED STEADY PROGRESS TOWARD REACHING GOALS

- At each Site, the ***STEM Coordinator*** served as the hub, connecting people within the school who had a role in the HSSP, working directly with SFAz and TERC, and, often, facilitating relationships with community members and business partners. Almost every Coordinator had another job with its own set of responsibilities outside the grant: Director of STEM (Alhambra), Curriculum Coordinator (Altar Valley); Superintendent/Principal (Congress), Special Projects Coordinator (Yuma); and Teacher (Bagdad and Salt River). Killip had a dedicated Coordinator, however his job required that he run activities and not just coordinate them. To a person, these Coordinators:

- kept lines of communication open and ensured timely reporting;
- took a lead role in writing strategic plans. To do this, he/she worked collaboratively with SFAz technical advisors, pulled in administrators and other staff as appropriate, and helped other members of the Site team to focus on the goals and progress of the grant;
- had frequent and direct contact with project participants (teachers, PD providers, community members) and were primary organizers of activities/resources (e.g., setting up professional development, preparing science kits for teachers to use, arranging field trip, working with the business office, etc.).

While all STEM coordinators claimed to enjoy many aspects of their role, some felt stretched by the paperwork and other reporting demands of the HSSP. Most stated that they needed more dedicated time to address the numerous tasks and additional workload fully.

- HSSP Site teams provided some support for each other, and they valued opportunities to share ideas and information. They appreciated the quarterly meetings offered by SFAz, and the STEM conference was a major highlight. While many felt comfortable directly calling someone from another Site to get their advice, they wished that SFAz had structured more opportunities for collaboration. Scheduling challenges were often a barrier to additional meetings for Site teams, however.

- All ***SFAz Technical Advisors*** supported STEM Coordinators and their teams to work within the process (e.g., write strategic plans), provide frequent updates (benchmark and budget reports), and disseminate their ongoing work (via newsletters, websites, and conferences). In last year's report, we analyzed Technical Advisor logs, calculating the hours reported to support each category of work (e.g., teaching, budgeting, evaluating, etc.). This year, technical advisors did not maintain logs, as their work was explicitly tied to enhancing sustainability of HSSP efforts. The following descriptions by Sites illustrate the type and extent of support they received from Technical Advisors:

  - provided connections to outside organizations and the community;
  - helped them remain focused on their STEM efforts and on larger issues;
  - notified them of professional development opportunities, encouraged and supported teachers and other staff to present their HSSP work at conferences;
  - kept the STEM coordinator going when overwhelmed;
  - enabled the project work to progress, especially during changes in leadership;
  - directly provided excellent PD and coaching and/or identified highly competent professional development providers;

- facilitated professional learning groups and/or co-planned with school coaches and facilitators of these group;
- offered feedback about curriculum and lesson plans;
- ensured positive accountability via monthly meetings;
- increased their level of confidence and decision-making, enabling them to build the best path toward their goals.

It is important to note that four of the Sites had the same Technical Advisor for all three years of project work. Three Sites had multiple Technical Advisors. While the latter group felt that each Advisor had the necessary expertise and were committed to assisting them, they did not express the same level of collaboration and communication as the Sites who had a single Technical Advisor. Still, when asked what types of supports made a difference and are necessary in running a successful school-based project, all cited their Technical Advisor as being essential.

- Last year, we provided an extensive report about how Sites used the ***STEM Immersion Guide*** to: establish a baseline and create a plan that would help them reach their goals; look at systemic changes that would need to occur across strands (leading, teaching, learning evaluating, budgeting, and sustaining); and evaluate progress. We also noted limitations and offered suggestions for improvement. Overall, the benefits of the Guide far outweighed its limitations, and in Year 3, Guides were still in use, informing work that would impact sustainability once the project ended.

  Based on each Site's systematic evaluation of their STEM Attributes using the Guide and from SFAz monitoring reports, we found that all Sites increased their level of STEM immersion. The Guide continuum moves from exploratory to introductory to partial and to full immersion models of STEM, and individual Site growth along this continuum is provided in Table 1 below.

Table 1: Change in STEM Immersion by Site

Site	Baseline Level of Immersion	Final Level of immersion
Alhambra	Exploratory	Partial Immersion
Altar Valley	Exploratory	Introductory ⇒Partial Immersion
Bagdad	Introductory	Elementary: Exploratory ⇒ Introductory High School: Introductory ⇒ Partial Immersion
Congress	Introductory	Partial Immersion
Killip	Exploratory	Full Immersion
Salt River	Exploratory	Introductory
Yuma	Exploratory	Partial Immersion

Final Outcomes: Teacher and Student STEM Attitudes

The Helios STEM School Pilot (HSSP) provided teachers with opportunities to improve their STEM knowledge and instruction, to integrate STEM more fully into their classes, and to work with school leaders to improve the STEM culture in their schools/districts. Through this work, teachers were expected to develop more positive attitudes, confidence, and knowledge related to their instructional roles in STEM and to notice changes in their students STEM skills over time. In turn, project leaders expected that students would develop more positive attitudes about STEM school work and careers and feel greater efficacy in STEM areas.

This report provides longitudinal results (growth over three years) from all seven HSSP Sites combined. Individual Site information will be provided directly to the schools/districts. TERC conducted the Teacher study and SFAz conducted the student study.

Instrumentation and data collection:

Instrumentation: To measure change in teachers' and students' perceptions, we employed two surveys, the T-STEM and the S-STEM, developed by the Friday Institute for their NSF-funded project *Maximizing the Impact of STEM Outreach* (MISO).

- The T-STEM asks teachers about their "STEM instructional practices, their confidence in teaching STEM subjects, and the degree to which they believe students' learning can be impacted by effective teaching" (Friday Institute, 2012). It also includes questions about their awareness of 21st century skills and STEM careers/resources. We selected a version of the survey that included sections for each STEM area.[1] Reliability coefficients for each portion of the survey ranged from .725 to .846.
- The S-STEM probes student perceptions about their STEM subjects and their anticipated college degree and career trajectories. Initially, we selected subscales to create a 56-item student survey. Feedback from HSSP teachers, in addition to program staff at Science Foundation Arizona, suggested that it would be too long and consume too much class time. As a result, the survey was shortened to a 28-item survey and then to a 15-item survey. The psychometric properties of the shorter versions were maintained. It should also be noted that in year 1, we decided to discard survey data from second graders as they were clearly not able to provide meaningful input. The MISO team in North Carolina stated this was not their experience with second graders.

Data: Teacher and student survey data were collected across four time points: at the beginning and end of year 1 (the 2013-14 academic year), at the end of the year 2 (the 2014-15 academic year), and at the end of year 3 (the 2015-16). STEM items included a 5-point scale with 1 being strongly disagree to 5 being strongly agree. Interpretation of this 5-point Likert assumes a neutral attitude at a mean of 3, a positive attitude for scores between 3 and 5, and a negative attitude for scores between 1 and 3. Subscale scores were

[1] Note: The T-STEM version for high school teachers was discipline specific and too in-depth for the vast majority of HSSP participating teachers.

created by calculating the mean score for math, science, and engineering and technology items.

Teacher Attitudinal Results

Overall Analysis: To measure change annually over the life of the project, our analytic approach has remained consistent. Once again, we conducted repeated measures ANOVAs that included a four-level within-subjects factor (i.e., baseline, year 1 post, year 2 post, and year 3 post). We also performed post-hoc tests on our results using the Bonferroni correction. Analyses were conducted only on HSSP teachers, since there were insufficient data from comparison teachers by the end of the second year of the project. Overall, we had 89 HSSP teachers who responded to the baseline; 108, to year 1 post; 111, to year 2 post, and 90 to year 3 post.

Comparing survey data prior to HSSP and at the end of the project, we find that teacher perceptions increased for all 7 subscales. It is important to note that with a limited 5-point scale, smaller increments of change can be meaningful. In addition, we point out that the scores of the 90 teachers at post-3 included some teachers who did not benefit from the full three years of HSSP (some were involved for 2 and a few for only 1 year). Still, the final group seemed to benefit, overall, no matter their length of participation as shown in Table 2 below.

Table 2

HSSP Teachers as a Group: Increases in Mean Scores from Pre to Post 3

Subscale	Pre (N=89)		Post 3 (N=90)	
	n	mean (SD)	n	mean (SD)
Science	67	3.77 (0.40)	77	3.87 (0.48)
Technology	20	3.46 (0.47)	28	3.73 (0.56)
Engineering	10	3.20 (0.83)	13	3.86 (0.65)
Math	64	4.00 (0.55)	68	4.10 (0.42)
Student Engagement	89	2.94 (0.76)	90	3.13 (0.84)
STEM Career Awareness	89	3.33 (0.91)	90	3.58 (0.94)
Technology Use in the Classroom	88	2.65 (0.95)	89	3.05 (0.94)

Longitudinal Analysis: To investigate the impact of HSSP on teachers who remained with the the project for three years and who provided data at each time point, we conducted additional analyses by subscale. Our results indicated:

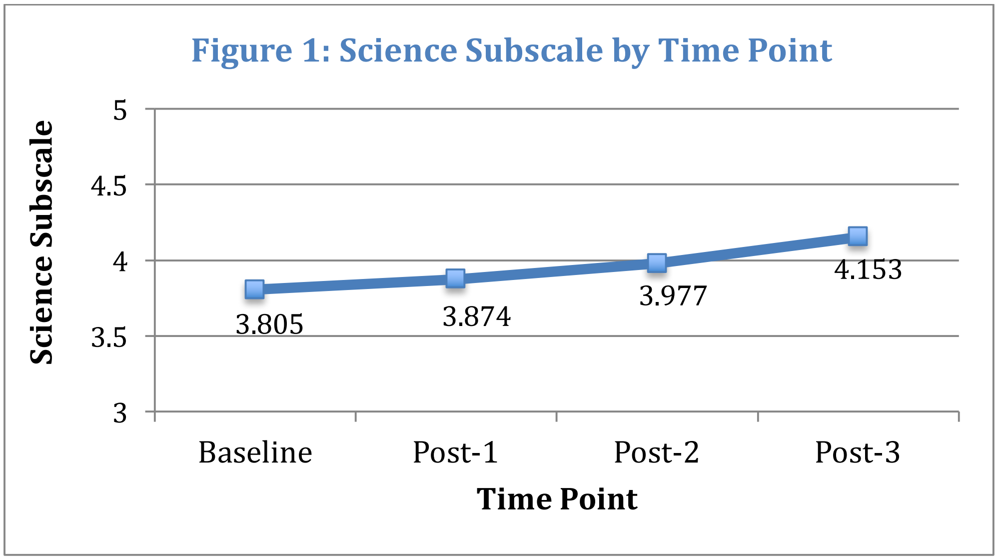
- that we had ***insufficient teacher data to conduct analyses on engineering and technology subscales.*** We learned that many did not teach engineering or technology, and therefore, did not complete these sections of the survey. This is not surprising, given that vast majority of project teachers were at the elementary and middle school levels where distinct units/courses in engineering or computer science were not offered.

- ***no change over time in teacher attitudes toward mathematics***. Given that most teachers had expertise in math prior to HSSP, they started with a higher sense of efficacy (note the high baseline score in Table 1 above), making any statistically significant increase harder to discern within this limited scale. In addition, many Sites did not concentrate on this area within the scope of the HSSP project.

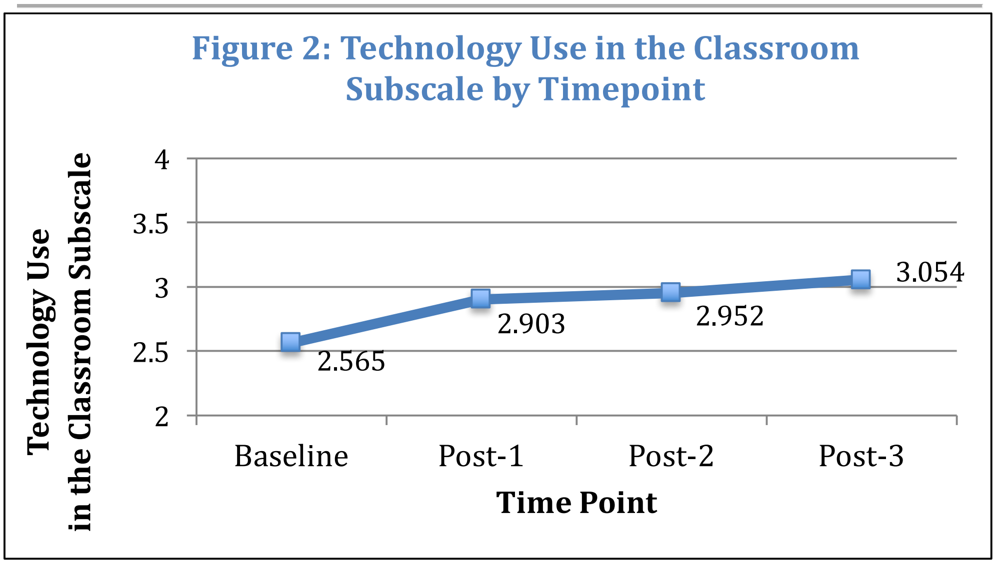
- ***statistically significant positive changes, over time, on the science, technology use, student engagement, and career awareness*** subscales. We present these data in greater detail below.

Discussion of Teacher Results

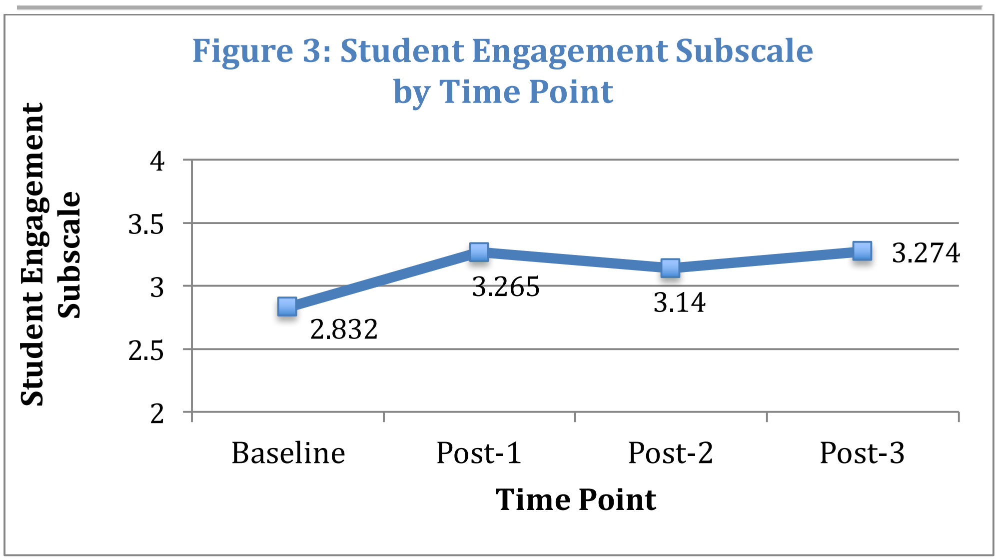
Science: As shown in Figure 1 below, the science subscale ratings of teachers who participated across three years increased significantly over time. The subscale ratings increased from baseline to year 2 ($p<0.05$) and from baseline to year 3 ($p<0.01$). This suggests that the teachers' sense of efficacy in teaching science (e.g., *I understand science concepts well enough to be effective in teaching science* and *I am confident that I can explain to students why science experiments work)* and their sense that strong science teaching is necessary for students to improve (e.g., *The inadequacy of a student's science background can be overcome by good teaching* and *Students' learning in science is directly related to their teacher's effectiveness in science teaching)* grew while participating in the project.



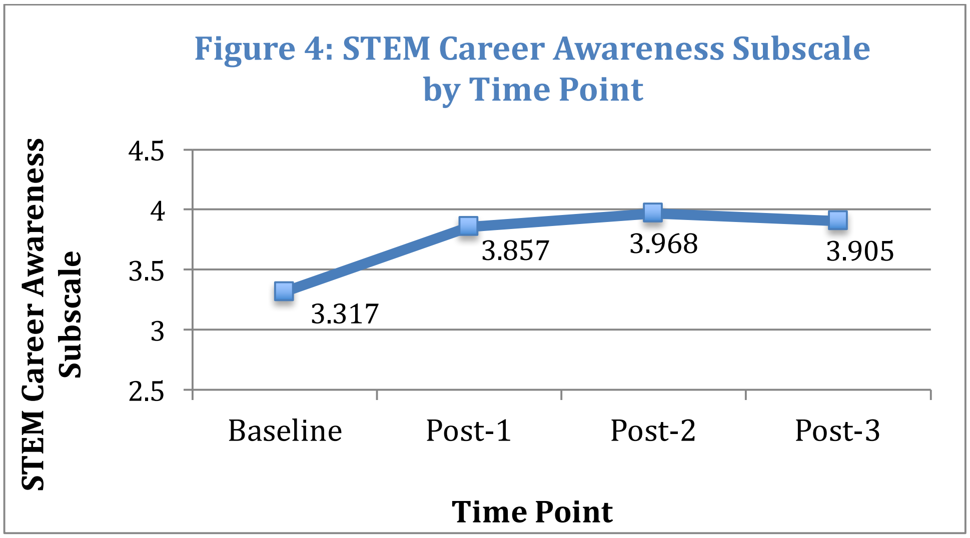
Technology Use in the Classroom: As shown in Figure 2, teachers indicated that their students' use of technology increased incrementally each year. Cumulatively, the change in their ratings was statistically significant ($p<0.05$) from baseline to the end of the Pilot. Teachers reported a greater use of different types of technologies for a range of purposes (e.g., *technologies for productivity, data visualization, research, and communication* and *work on technology enhanced projects that approach real world applications*).



Student engagement*:* As shown in Figure 3 below, teacher ratings of student engagement increased significantly during the first year (p.<01), plateaued in year 2, and then increased slightly again in year 3. Overall, positive change in teacher ratings from the beginning to the end of the project were statistically significant (p<.05). Over time, teachers reported more instances of student engagement in 21st century tasks (e.g., *Develop problem solving skills through investigations* and *Reason abstractly and quantitatively),* and showed greater recognition that their classrooms must provide opportunities for students to engage in 21st century skill development *(e.g., Manage their time wisely when working, Lead others to accomplish a goal,* and *Respect the differences of their peers).*



STEM Career Awareness: As shown in Figure 4, teachers' knowledge of STEM careers and resources increased over time. The most pronounced increase occurred within the first year of project work, with a smaller gain in year 2 and then a leveling off by year 3. Statistically significant gains were noted from the beginning of the project until the end of each year (<0.01 year 1, <0.001 year 2, and <0.01 year 3). While participating in HSSP, teachers reported increased knowledge of current STEM careers, where to go to learn more about STEM careers, and where to direct students or parents to find information about STEM careers.



Student Attitudinal Results

There were no significant changes in student attitudes as measured by the revised S-STEM survey. Descriptive findings show that, overall, students had more positive attitudes toward engineering/technology as compared with math and science, that students in older grades reported lower levels of interest and confidence than elementary students, and that males consistently reported higher levels of interest and confidence in math, engineering, and technology than female students. Gender differences for science were less consistent, but both boys and girls indicated that science was the least interesting STEM area.

However, we have limited confidence in these results. In considering why these data did not show the growth reported by administrators and teachers, we identified several factors that may have negatively impacted the quality and completeness of the student data set. These are presented below along with important lessons learned.

1. Our goal was to track survey responses per student over time. Students were asked to provide their state ID and name for tracking purposes, and teachers were asked to assist in this process. However, many claimed they did not have access to the full student ID, that their school would not permit using IDs, or they were uncomfortable providing this information, even though we assured them that student information would remain confidential, following all human subjects' requirements. In the first year, 50% of student baseline surveys were able to be matched to post surveys. In the second year this percentage decreased further. This situation, in combination with the fact that some Sites had very small numbers of students in each grade, forced us to change the design. We decided to examine changes in mean ratings for each grade level and not for individual students. This approach prevented us from identifying students who participated in HSSP for 3 years (versus those with just one or two years of exposure), and thus, *the rate of growth for students with higher levels of HSSP participation may be obscured by ratings of others.*

2. Exacerbating the aforementioned issues were problems with survey administration. It has been our experience that student ratings were less positive at the end of the school year, attributable to student fatigue. This is demonstrated most clearly in year 1, where baseline scores from the fall of a school year were often higher than end of year scores. Furthermore, we have concerns that students didn't always have sufficient time to complete their surveys.

Lessons Learned: While schools, with very good intentions, agree to administer student surveys when they enter a project, this may not be enough to ensure that usable data are collected. If schools cannot commit to providing some type of student identifier (even one that is used for the survey data only), it may not be fruitful to measure student attitudes via a survey. This is particularly true for schools/districts with high levels of student turnover, since the level of participation within each grade is like to differ in important ways. Also, we would recommend changing data collection strategies. Using researchers or trusted community volunteers instead of school staff might ensure more consistent data gathering. Changing end-of-year collection dates and supporting students who have limited experience with surveys, by clarifying the questions or process, would improve the chances that the data accurately represent student perceptions and attitudes.

We offer one final consideration. While each Site's strategic plan identified teacher and student outcomes, almost all intervention strategies focused on teacher improvement that would, ultimately, lead to student growth. The majority of time and money were devoted to developing/adopting curriculum, providing professional development aimed at improving teacher knowledge and pedagogical approaches, and building teacher leadership so that the positive changes could be sustained once the HSSP project ended.

Given the primary focus on teachers, we should expect to see teacher growth in the short term. This was the case. Teacher STEM attitudes significantly and steadily improved during the HSSP project. However, it takes longer for positive change in classrooms to translate into consistent student growth. Galileo annual assessment data offer evidence that this is starting to happen, as students significantly gained math and science knowledge and skill (see the next section of this report for details). Long-held beliefs and attitudes are often slower to change, however, and this may also account for uneven and lower student survey results. With improved data collection and more time to reap the benefits of teacher and classroom improvements, we expect there to be more discernable attitude changes for students.

Final Outcomes: Student Learning

A main goal of the HSSP has been to increase student STEM knowledge and skills through curricular and instructional improvements. The *Galileo K-12* is well-aligned with this goal, as it is a benchmark assessment designed to inform teacher planning and instruction and to provide data about student levels of mastery of standards at multiple time points in the school year.

In Year 3, TERC conducted the Student Learning Outcomes study, and once again collected Galileo *developmental scores* from six Sites.[2] Developmental scores capture student growth, indicating how far students move along the path toward achieving goals and meeting standards. Four Sites—Alhambra, Altar Valley, Congress, and Killip—provided both math and science data sets. Two Sites provided only one data set. Salt River Elementary sent only math data as they do not use Galileo Science in their school, and Yuma sent only science data as their HSSP strategic initiative doesn't focus on math. For the most part, each Site submitted data for all grade levels participating in the HSSP. However, in a few cases we did not receive data for students at a particular grade because the school did not assess that grade level with Galileo.

Overall Student Growth Across Sites: We calculated gains by comparing scores from the first Galileo assessment, given at the beginning of the school year, to scores on the final assessment given at the end. Then, we tested whether the gains that students made were statistically significant, using hierarchical linear modeling (HLM) to account for the influence of teachers and classrooms on student scores. This year:

- the average gain in mathematics scores across participating Sites was 101 points, representing a *significant change in students' math knowledge* during the academic year ($p<0.001$).
- the average gain in science scores across participating Sites was 55 points, indicating a *significant increase in students' science knowledge* during the academic year ($p<0.001$).

This year's results mirror those from last year, when we also saw sizable gains that were statistically significant. Overall, this indicates that the Sites are continuing to support student learning that leads to growth in math and science knowledge and skills as measured by assessment items tied to standards. We can't track individual student scores over two years because each year's benchmarks are grade-specific, and thus, the areas assessed and types of scores generated vary from year to year. However, the fact that the student population is fairly stable at most Sites suggests that students made steady progress in math and science learning during years 2 and 3 of the project.

Student Growth at Each Site: In addition to these overall gains, we identified statistically significant gains in math and science in at least two grade levels within each Site. *Most Sites saw significant gains for students in all or almost all grade levels.* Significance at higher

[2] Bagdad School District only uses the state assessment.

threshold levels allows us to feel more confident that these gains are not due to chance. It is also likely that there is less variation in scores—that is, the gains are more consistent across the group of students being measured.

Gains by site are provided in the table below. Note that when the number of students (N) is very small, results from one or two students or a lot of variation within the data set can dramatically influence whether the gains reach a level of significance.

Galileo Gain Scores by Grade Level at Each Site

District	Grade (N)	Average Math Gain +/- points	Grade (N)	Average Science Gain +/- points
Alhambra				
	8 (351)	+77***	8 (351)	+81***
Altar Valley				
	5 (64)	+3	5 (64)	-3
	6 (23)	+18	6 (23)	+1
	7 (67)	+42***	7 (68)	+28***
	8 (63)	+172***	8 (64)	+58***
Congress				
	2 (10)	+125***	2 (0)	no data
	3 (8)	+158***	3 (8)	+69**
	4 (10)	+86**	4 (10)	+98***
	5 (12)	+202***	5 (12)	+98***
	6 (8)	+160***	6 (8)	+121**
	7 (9)	+81**	7 (9)	+38
	8 (9)	+123***	8 (9)	+70*
Killip				
	2 (66)	+192***	2 (67)	+132***
	3 (90)	+87***	3 (84)	+70***
	4 (63)	+81***	4 (61)	+94***
	5 (74)	+121***	5 (71)	+24**
Salt River				
	4 (40)	+71***	4 (0)	no data
	5 (28)	+101***	5 (0)	no data
	6 (13)	+73***	6 (0)	no data
Yuma				
	5 (0)	no data	5 (456)	+42***
	6 (0)	no data	6 (463)	+48***
	7 (0)	no data	7 (478)	+43***
	8 (0)	no data	8 (519)	+56***

***significant at the <0.001 level
**significant at the <0.01 level
*significant at the <0.05 level

Promising Practices, Future Plans, and Challenges Related to HSSP Sustainability

Based on data gathered from Site visits, Site sustainability plans, interviews with HSSP Site leaders and technical advisors, and observations of final review meetings, we have identified current practices and future plans likely to ensure that HSSP work remains embedded in each Sites' operations and culture. In some instances, we juxtapose this promising evidence with situations and decisions that could negatively influence sustainability.

Many of the Sites carefully and systematically transitioned from having grant funded project activities to embedding them in normal educational practice within their school system. These are described below with examples from individual Sites. Counter examples are listed, when needed, to identify challenges to sustainability.

Funds incorporated into school district budgets or obtained through new grants will allow Sites to continue implementing successful HSSP activities

- Funding Professional Development will be maintained:
  - Alhambra will assume responsibility for funding Action Lab professional development this summer for their continuing and new teachers. This ensures necessary expertise to run Labs at three middle schools in the 2016-17 academic year.
    - *Counter:* As of yet, there is no commitment of PD in future summers.
  - In year 3, Altar Valley did extensive professional development and the district has made certain that even if some teachers change grades, others will remain to support new colleagues. Funding for grade group meetings will be maintained so that new and veteran teachers can collaboratively plan FOSS science lessons, and the curriculum coordinator has agreed to support teachers as needed.
    - *Counter:* While the curriculum coordinator is a skilled educator, she does not have deep experience in science. She may need funds to engage the Technical Advisor (who lives in the area) or another expert to support her as needed.
  - Congress will continue their practice of dedicating time each week for grade group teams to share STEM work as they transition to project based learning.
  - Several districts identified funds for conference attendance and travel so that teachers can continue to build their expertise and further develop as teacher leaders.

- Funding leaders and external experts
  - Alhambra has increased funding for the Director of STEM—the position will move from half time to full time. Also, a grant-funded engineering teacher will be funded by the school system going forward.
  - Yuma will use district funds to pay the Technical Advisor to work with teachers, and funding for science coaches will be maintained.

- Several Sites have secured new grant money, allowing them to maintain HSSP activities or leverage these activities as they expand their STEM offerings.
    - Killip and Bagdad have new grants that will support their successful STEM coordinators, previously funded by Helios.
    - Bagdad has committed to matching mini-grants (less than $1000) that teachers receive.
    - Yuma teachers will be invited to join other science teacher cadres funded by their DoDEA grant.
        - *Counter:* While the former HSSP cadres were doing similar work as those funded by DoDEA, they don't have an ongoing relationship with these teachers. Also there are no stipends/incentives to join, so teachers will need to voluntarily attend.

Expanding and embedding HSSP activities will increase STEM opportunities for students and will solidify connections to ongoing work of schools and districts

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- Some Sites are expanding activities to enable greater teacher and student participation.
    - An additional Action Lab classroom will begin at a third school in Alhambra in the next academic year, so that more students in the district will have an engineering experience.
    - In Altar Valley, the number of Action Lab modules within the classroom has increased so that the entire 8th grade can participate fully and, in future years, greater numbers of younger students will get partial Action Lab opportunities.
    - Bagdad's hiring practices aim to increase and diversify the number of CTE electives and afterschool activities in STEM. They plan for continuous turnover by cultivating new hires who will use their talents and interests to create new courses/activities. For instance, when a teacher with aeronautics experience left, a new teacher was hired who could offer hydroponics.

- Work has been done to embed HSSP activities in initiatives or programs for which the school/district will remain committed.
    - The Culture Department at Salt River Elementary is strong and has the commitment of the community. Therefore, HSSP leaders worked collaboratively with Culture staff so that STEM and culture activities could be integrated. Similarly, they worked with the tribal environmental staff to integrate STEM beyond the school day.
    - Killip has applied to the the Flagstaff district governing board to become a STEM Academy, further ensuring that immersive STEM curricular units will not only remain but grow.
    - Summer programs are popular at many Sites. Thus, by including STEM camps—notably in Altar Valley and Salt River—students and their parents stay engaged in STEM year round.

        - *Counter:* Space at camp is limited and STEM camps fill quickly. Thus, only a small percentage of students may benefit from this offering.
    - Multiple Sites are moving their HSSP work under the 21st Century Skills umbrella. By connecting with these school-wide initiatives, problem-solving, critical thinking, and collaborative work—inherent in STEM learning—can strengthen the new initiative and ensure that STEM is still addressed.
        - *Counter:* Some school- and district-wide initiatives hindered HSSP progress. This occurred when there was a new initiative that required extensive teacher involvement. Teachers often devoted a good deal of effort to professional development and to adapting their instructional practice. When they felt overwhelmed, they were less likely to sustain HSSP obligations.

Structures and plans for HSSP resources will contribute to sustainability

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- Knowing where resources are stored, creating simple processes for check-out, and having someone responsible for their upkeep allows for continued use long after the project ends.
    - Multiple Sites have created structures making resources sturdy and portable so they can be shared among teachers (e.g., STEM curricular units). Similarly, Sites have specific plans for continued use, and in some cases expansion, of resources purchased with grant funds (e.g., robotics kits).

- Upgrading resources is essential and funding for maintenance is necessary.
    - As Sites have expanded programs, they assessed their resources and identified those that need updating. Thus, they have specific plans in place (and some have begun to implement these plans) to purchase new software, upgrade operating systems, and find alternatives for what they already have (e.g., adding to their expensive Lego Robotics kits with more cost-effective Dash and Dot robotics kits).
        - *Counter:* At this point, smaller and relatively affordable updates are being made. It will take a higher level of support to replace bigger ticket items.

System and cultural changes make STEM more visible and sustainable

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- With the number of needs and issues that schools and districts must constantly address, it is essential that STEM educational opportunities remain in the foreground to ensure sustainability. To that end, we identified a clear presence of STEM opportunities at some Sites.
    - Alhambra will have STEM representation on new district planning team.
    - Killip is creating a school-wide strategic plan for the next two years with an emphasis on STEM goals.
    - Site participants have increased their capacity to evaluate STEM products, curriculum, and programs—including numerous types of technologies—as a

result of their HSSP work. They now can identify and advocate for the purchase of STEM products that will fulfill their needs and can be used effectively.
    - *Counter:* This increased capacity is often held by just a few people who were leading the HSSP effort. Approaches need careful documentation that is shared with a number of people so that capacity isn't lost when staff move.

- At many Sites there has been a cultural shift in the way that administrators, teachers, students, and parents view science, technology and engineering. These subject areas are seen as increasingly important and, at some Sites, they have become *as important* as ELA and mathematics. The following are examples of cultural shifts that keep STEM at the forefront:
  - Killip and Congress have moved from subject silos to integrated instruction. There is a place for science in an ELA classroom, for instance, and teachers identified ways in which science brings new life and opportunities to ELA learning.
  - Key cultural shifts at Sites make faculty induction clearer, as instructional goals become more overt. For instance, in grades 9-12 in Bagdad, the commitment to CTE courses for all high school students (and to maintaining a few full CTE programs) influences learning expectations in all classrooms.
    - *Counter:* Cultural shifts were thwarted when key leaders at multiple levels left a school system and weren't replaced by people who understood the goals and expectations of the HSSP. In Salt River, especially, a number of administrative roles (superintendent, principal, curriculum coordinator) were vacated several times during the course of the project. In some cases, new leaders were barriers to progress, dismantling structures (e.g., the sustainability committee) and impeding the work of the STEM coordinator. As a result, progress was hindered and STEM activities were not as widely supported.

- Most Sites did not involve all of their teachers in the grant directly. However, all Sites did include teachers who were respected by their colleagues. Their continued participation in STEM instruction will continue to "win over" those who are skeptical, especially about engineering and computer science.
    - *Counter:* Some of these teachers are likely to retire or move to a new district in the near future. Sites need to have a plan in place so that programs don't dissolve when this happens.

- Use of technology has expanded across Sites. In some, it is now a primary vehicle for learning, not an add-on. For instance, technology is used to enhance data collection during science investigations and to improve communication skills within English lessons.

- There has been some movement toward inquiry science, with an emphasis on strengthening problem-solving skills and increasing student ability to conduct scientific investigations. If this becomes more widespread, it will be less likely that Sites return to learning science only by reading about it or through hands-on activities that are devoid of opportunities for sense-making.

        - *Counter:* State standards may interfere with the development of this deeper science teaching and learning, as they preference ELA and don't offer higher level science goals. As one administrator explained: "…until the state fully engages in the science conversation and [acknowledges that] we're using standards from a decade ago…science will continue to be an area [for which schools are not] held accountable and are not making it a priority."

Increased community awareness and involvement contributes to sustainability

- HSSP required Sites to create partnerships within the community, both raising awareness of the importance of STEM and tapping into the expertise surrounding them. As a result of these partnerships, some Sites will have opportunities to extend programs and stretch limited funds by using volunteers with STEM expertise. In addition, aware parents and community members may be more willing to support budget increases related to new technologies and other costly items. Examples of work with the community that might contribute to sustainability are listed below.
    - Congress engaged retirees from industry to participate in HSSP activities. This was particularly important since there are few businesses in the area from which they can draw STEM experts.
    - STEM Showcases/Nights were identified as a "huge success" by several Sites (Salt River, Alhambra, and Altar Valley), because they attracted large numbers of parents which has not typically been the case.
    - Competitions that involved STEM created a lot of excitement within and beyond the school campus. Bagdad participated in several that were tied to student CTE work.
    - Ties were strengthened between Sites and organizations/businesses including: Intel, Freeport-McMoRan, Buenos Aires National Wildlife Refuge, Trico Electric, Forest Highlands Foundation, and AZ Agriculture Extension Services.
    - Nearby colleges and universities offered support (e.g., affordable PD, guidance, volunteers) to most of the Sites
        - *Counter:* Work with the community was not a primary focus of any Site, as a great deal of effort was focused on addressing needs of teachers and students. Therefore, while some community relationships were strengthened and some new ones were established, they will need more attention in order to be maintained.

It will take a concerted effort to respond to the challenges that threaten each Site's accomplishments. However, if addressed, the notable progress of the Helios STEM School Pilot is likely to be sustained, allowing these strong STEM educational communities to thrive well into the future.