STRENGTHENING STEM IN ELT SCHOOLS

Final Report on a Demonstration Project Funded by The Noyce Foundation

NATIONAL CENTER ON TIME & LEARNING

By David Farbman & Claire Kaplan

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Project Summary

Background and Key Outcomes

In March 2014, The National Center on Time & Learning (NCTL) launched Strengthening Science in Expanded-Time Schools, an innovative project to expand and enhance STEM instruction aligned to the *Next Generation Science Standards* (NGSS) in expanded-time schools. With support from the Noyce Foundation, NCTL worked with five expanded-time schools, each paired with a science-focused community-based organization, to embed new, imaginative STEM programming in a redesigned and expanded school day. Each of the schools, which received a modest planning grant and technical assistance coaching from NCTL, have created their own program model and way of engaging students. Together, they enable over 1,200 students to participate in exciting, inquiry-based learning activities and projects that augment their interest in and knowledge about science and engineering.

Background

With the release of the *Next Generation Science Standards* and the intensive focus on boosting proficiency and interest in science, there are rising concerns that our public schools are not in a strong position to meet these higher expectations for learning. Two significant barriers stand in the way of students engaging deeply with challenging content and the complex scientific method of collecting, analyzing and applying data. First, teachers, especially at the elementary level, are not well-trained to guide students through the multilayered processes set forth in the new standards. Second, schools, especially those struggling to meet proficiency targets in literacy and mathematics, do not allocate sufficient time for either formal or informal science learning. The 2012 National Survey of Science and Mathematics Education offers dramatic evidence that these concerns are well-founded. This survey revealed that fewer than four in ten elementary teachers (39%) felt comfortable teaching science and that elementary students learn science for, on average, fewer than 25 minutes each day—not nearly enough to engage in the kinds of hands-on, high-quality experimentation and analysis that experts agree are vital to building scientific knowledge and interest.

Second graders from Centennial Elementary School show off their simple machine puppets.

As NCTL described in its 2011 report *Strengthening Science Education: The Power of More Time to Deepen Inquiry and Engagement*, funded by the Noyce Foundation, expanded-time schools offer a tremendous opportunity to overcome both of these disturbing trends.

With more time in the daily schedule, students can have at least an hour per day to engage deeply with scientific content and process. This additional time also opens up pathways through which schools can bring partners (e.g., science museums, non-profit organizations or other educational institutions) into the regular school day in order to further strengthen instructional and programmatic quality for all students.

Students at Escuela Bilingüe Pioneer build "squishy circuits" to explore the properties of electricity.

A recent tally by NCTL reveals that over 2,000 schools across the country have intentionally expanded their school calendar to offer students more learning time. These expanded learning time (ELT) schools are striving to close achievement and opportunity gaps by offering students more time in core classes, more opportunities for personalized learning, intervention and acceleration, and more time for engaging enrichment activities. Most of these schools, however, have not yet realized the full potential of an expanded school day to enhance and enrich STEM education.

Project Description

In order to stimulate the creation of new and replicable models for creating quality STEM education, the Noyce Foundation partnered with NCTL to launch a network of ELT schools that each would seek to implement new STEM programming. Through this network, educator teams comprised of teachers and staff from community-based science organizations would work together to plan new STEM programming that capitalized on the school's expanded schedule. By participating in the network, teams would:

a. Obtain planning grants to support the development of a model of STEM education designed to meet their student's needs;
b. Receive coaching as they developed their models;
c. Learn from other network participants through onsite sessions and remote communication; and
d. Put a system in place for tracking continuous improvement.

Schools and partners receiving the planning grant, coaching and technical assistance would be selected on the basis of merit through a competitive request for proposal (RFP) process in which they demonstrated that they would:

- Increase the amount of time students participate in engaging, hands-on science programming by at least one hour a week for all students;

- Form (or strengthen) a partnership to provide hands-on science programming aligned with the NGSS; and
- Train and support teachers on implementing NGSS and high-quality, hands-on, science programming.

With the assistance of The After School Corporation (TASC) of New York, an expert in improving STEM education in expanded-time schools, and Noyce Foundation technical advisors, NCTL selected five schools and their community-based science partners in June 2014 to participate in this demonstration project that would entail planning (July 2014 – December 2014) and preliminary implementation (January 2015 – June 2015). The grantees and a summary of their activities are listed in Table 1.

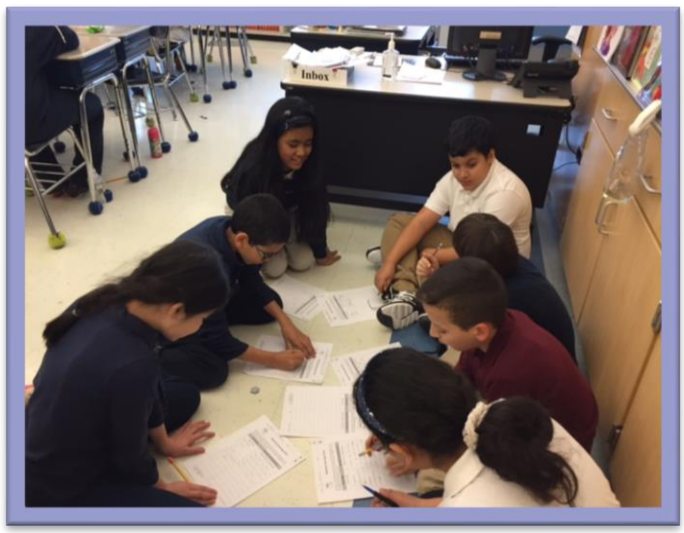
TABLE 1
Schools and Partners Selected for Participation in
NCTL's "Strengthening Science in Expanded-Time Schools" Project

School	Partner	Students Served	Location	Brief Description
Pennington Elementary School	Denver Children's Museum	Grades: K – 2 Students: 120	Wheat Ridge, CO	✓ Developed STEM enrichment curriculum and worked with an additional partner organization (YMCA) to plan and deliver science enrichment programming ✓ 50-minute weekly STEM enrichment block, focused on human physiology, forces and motion, and animal characteristics/habitats
Centennial Elementary School	Eurekus	Grades: 2 – 3 Students: 100	Denver, CO	✓ Operated workshops, developed by Eurekus, focused on using art projects to convey science concepts, connected to science class curricula ✓ 90-minute weekly workshops led by artist educators, in coordination with a full-time science teacher
John Barry Elementary School	Meriden YMCA	Grades: K – 5 Students: 515	Meriden, CT	✓ Created five 8-week STEM modules aligned with grade-level science standards and mapped to units studied in science class with engaging hands-on projects ✓ Offered during 90-minute enrichment block, led by Barry teachers and partner staff
Escuela Bilingüe Pioneer Elementary	Denver Museum of Nature and Science	Grades: 2, 4 Students: 240	Lafayette, CO	✓ Infused STEM curriculum into core academic classrooms, developed by school staff and partner; units on Force and Motion and Electromagnetism ✓ Programming also supported through weekly project-based enrichments
AC Whelan Elementary School	Blue Heron STEM	Grades: 4 – 5 Students: 250	Revere, MA	✓ Partner trained 4^{th}, 5^{th} grade math/science teachers to implement Boston Museum of Science's *Engineering is Elementary* curriculum in core academic classes (daily 60-minute lessons in four-week cycles) ✓ Focus on engineering process from design to implementation to design improvement; integrates literacy skills

Selected schools and their partners received small planning grants ($10,000-$12,000) to pay teacher leaders and community partners to work together to develop new curricula and plan programming. In addition, NCTL designed a series of three technical assistance sessions for participating schools and their partner organizations to share best practices and model programs, support planning efforts and facilitate school-to-school sharing of ideas. These full-day training sessions took place at: (a) a STEM-focused high school in Worcester, Mass.; (b) Thompson Island Outward Bound Education Center in Boston Harbor; and (c) the Media Lab at MIT in Cambridge, Mass.

Content at these sessions included:

- Teaching participants about the six strands of effective STEM education (as delineated in the National Research Council's *A Framework for K-12 Science Education*) through a series of activities and videos demonstrating how to activate these strands in a classroom setting. (See Appendix A, page 31, for a brief summary of these strands.)
- Communicating the principles of effective partnerships between schools and community-based organizations and allowing significant work time for school and community partner staff to map out how they would work together throughout the project.
- Sharing interesting projects, partnerships and resources, including technology educational games developed by MIT's Scheller Teacher Education Program and extensive information about funders focused on improving STEM education in elementary and middle schools.



Whelan Elementary students conferring about their latest engineering project.

- An optional visit to the Boston Museum of Science Teacher Professional Development Center to obtain additional resources and program ideas.
- Tools for evaluating outcomes and program quality. (See Appendix B, page 32, for an abbreviated version of the program quality rubric.)

Perhaps most important, technical assistance sessions explored the fundamental question of what is meant by "quality STEM education." And while there is no single quick definition that can capture this concept fully, sessions emphasized what the National Research Council has asserted about the best way to approach instruction and engagement in science learning. As described in its publication, *Ready, Set, Science!*:

> This framework rests on a view of science as both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. This framework moves beyond a focus on the dichotomy between content or knowledge and process skills, recognizing instead that, in science, content and process are inextricably linked…. When children use their ideas about the natural world to design investigations or argue about evidence, it strengthens their understanding of both the phenomena and the means used to investigate those phenomena.[1]

Between the three technical assistance sessions, grantees received support from NCTL's expert coaches as they worked to finalize their plans for improved and expanded STEM programming. Throughout, coaches continued to emphasize the directive to re-think how to engage students in scientific learning, shifting from a knowledge-delivery focus to one that instead revolves around activities that generate knowledge through inquiry.

Project Outcomes

The most significant outcome of this effort was the creation of five distinct program models that engage students in innovative STEM activities and encouraged teachers and community-based partners to develop STEM instruction that adheres to both the content and the spirit of the NGSS approach. All five programs will continue (and even expand) for School Year 2015 – 16, even as the NCTL support ended in June 2015.

The following pages offer detailed descriptions of the five program models, including the nature of the partnership between school and community-based organization, a summary of the STEM content in which students participated, and a report on preliminary outcomes from the first six months of program implementation. Descriptions are generated through a combination of self-reporting by each partner group and day-long site visits by NCTL staff to gather qualitative and quantitative data. In addition, four of the five sites conducted a survey of students to gauge their perceptions about their participation in STEM programming. (Results from a selection of questions are displayed for each site individually in the profiles, with full data reported in Appendix C, page 35.) Survey questions were drawn from the Youth Attitude Change Measure developed by TASC.[2]

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[1] S. Michaels, A.W. Shouse, & H.A. Schweingruber (2008). *Ready, set, science! Putting research to work in K-8 science classrooms*. Washington, DC: National Academy Press, p. 17.

[2] See Y. Wang, A. Hoxie and C. Smith (2011). *Evaluation Findings from the Frontiers in Urban Science Exploration 3.0 Program*, Appendix, p. 33.

PROFILE 1

Pennington Elementary School

Wheat Ridge, Colorado

FAST FACTS

Grades: K – 6

Enrollment: 235

Low-income population: 86%

Daily schedule: 7:50 – 4:20

Spinning tops and blowing on pinwheels, the second graders from Pennington Elementary are not just playing with toys. They're learning about basic scientific principles of force and motion. "Tell me again why the top stops spinning," says Conor Ryan, an educator from the YMCA. "Friction," replies a boy quickly. "And why else?" Ryan prompts. "Gravity," responds another boy, smiling as his top's spin outlasts his friend's. "Right. Now be sure to record that in your notebook, okay?"

Once a week, these students gather in this side room off the library, in the gym or in other classrooms to try fun and simple experiments and activities as part of their extensive afternoon enrichment program. With a curriculum developed in partnership with the Children's Museum of Denver and staffed by eager educators from the nearby YMCA, STEM education at Pennington has taken a large leap forward thanks in large part to Pennington's eight-hour day, which allows for a broader array of educational programming to become wrapped into students' whole school experience.

Program Basics

Two factors led Pennington to direct STEM programming to grades K – 3. First, as much as Jefferson County Public Schools wants all students to be learning science, the district has not provided high-quality, standards-aligned science curricula for the lowest grades. Second, for Pennington, a school that has persistently failed to achieve high rates of proficiency in ELA and math (not to mention science), the emphasis for instructional improvement has been on literacy and math. Science has had to take a back seat, especially in grades K – 3. (Older grades have designated times during the week for science instruction as part of core academics.)

Pennington second graders use pinwheels and balls to identify some of the properties of force and motion.

The situation changed with the conversion to a longer day in the 2013 – 14 school year, however, when school leadership at Pennington saw an opportunity to build STEM back into the curriculum for younger grades through the daily enrichment programming in which all students participate. Through participating in the NCTL/Noyce network, Pennington was able to commit to providing quality STEM enrichments once per week.

In these new enrichment blocks, Pennington students were enrolled in one of the following classes: Matter, Healthy Hearts, Beanie Baby Habitats, Coats, Weather, Forces and Motion, Humpty Dumpty or Motion. These topics intentionally relate back to NGSS and the district standards. Using the Engineering Design Process in content delivery, the lessons are intended to increase engagement and enrichment among younger children so that they have a head start when they start to learn science as part of the regular curriculum in Grade 4.

Students engage in a sorting activity as part of the Weather unit.

Unit Highlight

As part of the enrichment class "Forces and Motion," students engage in a series of lessons about animals and the types of movements they make. For example, in one lesson, students must observe, describe, and compare the position and motion (speed and direction) of people, animals and objects and be able to categorize different animals based on the way(s) in which they move. They are even required to make predictions about the movements of various animals in order to demonstrate their full understanding of the concept.

The lesson links directly to one of the core NGSS standards of the primary grades: describing in speed and direction the variety of ways objects, animals and people can move. Integrated into the lessons as well are some key vocabulary terms, including "energy," "inertia" and "force."

Dual Partnership with the Children's Museum and YMCA

Even as Pennington Elementary leaders very much wanted to use the enrichment block as the entrée into quality STEM education, they also recognized that neither the primary grade teachers nor the YMCA staff had the expertise to develop a solid curriculum and lessons that would engage students and expand their knowledge base at the same time. Leveraging the planning grant and structured planning process provided through participation in the NCTL/Noyce network, Pennington partnered with the Children's Museum of Denver: first, to adapt existing science resources and curricula to the primary grades, and, second, to provide professional development to the YMCA educators—the sole staff of the enrichment sessions—in implementing the science units.

The result of this three-way partnership has been that Pennington students now participate in content-rich science lessons led by staff who have been trained to push students toward a deeper understanding of scientific concepts while still emphasizing fun and play.

Outcomes

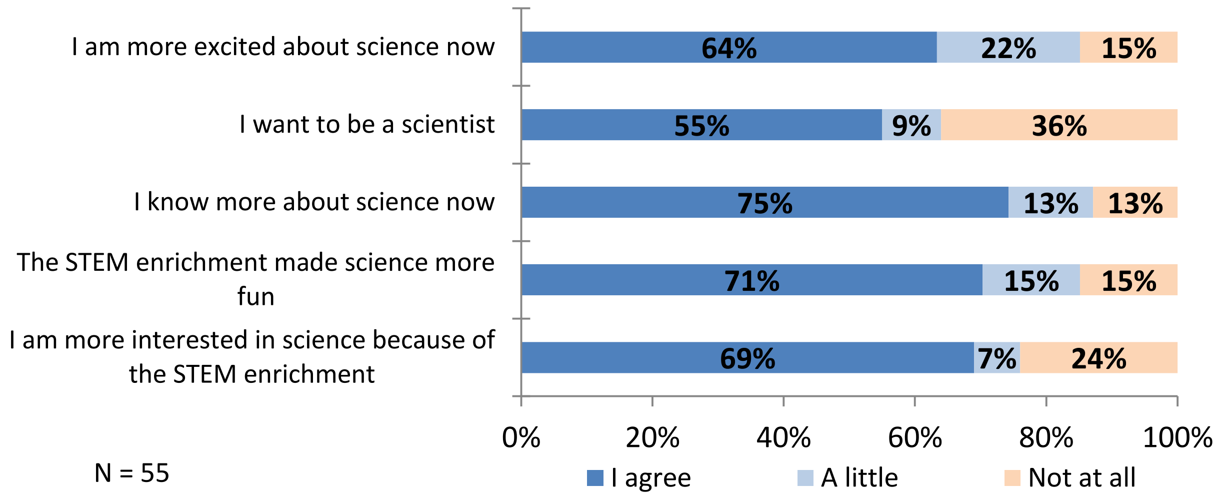
Pennington Elementary can boast two key results from this new STEM programming. The first relates to program structure. By having the Children's Museum help to train YMCA staff and Pennington teachers around how to create quality STEM programming, the school has built a corps of educators who can implement lessons for the foreseeable future. With knowledgeable staff now in place, the program's sustainability is much stronger.

Conor Ryan, YMCA educator, watches as a student tests the spin of his top in the "Forces and Motion" enrichment class.

The second outcome revolves around student engagement. Surveys of students show a high level of interest in STEM and that, possibly, they have begun to develop a firmer concept of what science is. (See Figure 1.) Teachers even report a higher level of engagement in enrichment overall, not just in the weekly STEM activities.

After just six months in place, it is difficult to know the longer-term impact of this programming and whether participating in these STEM enrichments will carry over to science class when students reach higher grades. The Pennington educators remain hopeful that this array of experiences will lead students to approach the formal study of science with greater interest and a firmer base of knowledge.

Figure 1
Survey of Students Who Participated in STEM Enrichment Programming at Pennington
Percent of Students Responding, May 2015



N = 55

Note: Because the survey was conducted of students in primary grades, Pennington staff modified the language of the questions and scaling from the standard TASC survey. In addition, Pennington staff delivered some surveys orally to assist younger students in understanding and responding to the questions.

PROFILE 2

Centennial Elementary School

Denver, Colorado

FAST FACTS

Grades: PK – 5

Enrollment: 500

Low-income population: 70%

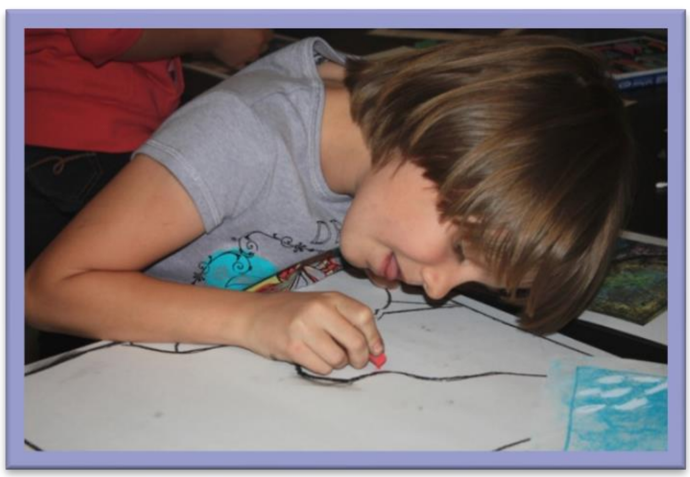
Daily schedule: 8:00 – 3:50

The room is buzzing with excitement. "Look at mine!" one third grader exclaims to her teacher as she holds up her latest creation. "I made the river." "Terrific!" the teacher, Monica Aiello, responds. "I'm so proud of you. Now see if you can figure out how to draw the land masses, too." Quickly, the student returns to her pastel rendering of a satellite photo of the Colorado River.

This girl is one of about 25 students in the room, each of whom is drawing his or her own version of similarly stunning pictures taken from space by NASA satellites. As part of the project, students become "water detectives" by using visual clues to determine how water has shaped the land and how civilization has developed the land around water use. The activity is all part of a unit on water—its uses, its properties and how it shapes geological development—run by a husband-and-wife team of artist educators who have made Centennial Elementary school in Denver their home on Wednesday afternoons. In their work at Centennial, Monica and Tyler Aiello enable students to access and explore complex scientific concepts through art forms, including drawing, video production and drama.

Program Basics

The STEM enrichment programming at Centennial is not disconnected from the larger educational experience, but rather built firmly on its pillars. Because Centennial is part of the Expeditionary Learning (EL) network, teachers are already geared to promoting (and students to engaging in) active learning with multi-disciplinary projects. The school contracted with Eurekus—the organization founded by the Aiellos—to run sessions for second and third graders during the 90-minute enrichment blocks held every Wednesday afternoon.[3] Eurekus was chosen especially because its philosophy and approach align well to the EL system.



A student acts as a "water detective" by sketching the Colorado River from a satellite photo.

[3] Classes end at 1:30 on Wednesdays. While all students participate in 90 minutes of enrichment programming of various types, teachers participate in school-wide professional development.

To engage students in science learning, Eurekus practices what has become known as STEAM, a variant of well-known STEM (Science, Technology, Engineering, Math) education. Conventionally, the "A" stands for "art," but Eurekus takes a broader view, using their interaction with students to integrate not only the fine arts but also the liberal arts to provide some historical and cultural context. For Eurekus, students should come to understand the world in which they live not through siloed subjects, but as a holistic, integrated body of knowledge. Throughout, Eurekus educators emphasize: (a) structured collaboration in design and execution; (b) a trial-and-error method rooted in creative problem solving; (c) a multidisciplinary approach, including integrating several art forms, literacy, and scientific content; and (d) the placement of learning in a broader historical and cultural context to draw conscious connections to students' lives.

In the 2014 – 15 school year, Eurekus implemented three units: (a) Simple Machines, (b) Fresh Water Systems, and (c) Frogs & Adaptations.

Unit Highlight

The unit undertaken with the second graders aimed to teach about the six simple machines through particular project, each focused on a different machine. These included:

- Blow & Go Racers (Wheels & Axles)
- Lever Thumb Puppets, Lever Launchers (Levers)
- Pulley Primates (Pulleys)
- Pneumatic Rockets (Wedges)
- Inclined Plane Maze (Inclined Plane)
- Automata Theater Box (Complex Machines)

These automata theater boxes combine several of the simple machines that students had already worked on.

Throughout these projects, students are pushed to think critically about how simple machines form the building-blocks of more complex engineering, from modern construction equipment to the Mars rover. Students also investigate how the development of simple machines forged major innovations throughout human history, from the water wheel to the building of our ancient cities. The capstone project is creating a stop-motion animation video, through which students synthesize their understanding of simple machines by developing narratives that explain how the machines work and the students' inspiration for making them. (Video available here: https://vimeo.com/115366690.) Throughout, students engage in the creative process in tactile ways through research, story-boarding, making (using simple machines), technology, editing and sharing. Students work in small and large groups to foster their sense of responsibility *to* the class and school community.

Partnership with Eurekus

Even though Monica and Tyler Aiello entered the school as independent educators, they are committed to integrating their curriculum as much as possible into Centennial's academic curriculum. Likewise, Centennial second- and third-grade teachers are committed to building on the Eurekus activities throughout the week in their science classes.

A student displays his foldout book featuring the water cycle.

The connection between the content of Eurekus enrichment sessions and classroom science instruction has been facilitated by Cenntenial science teacher Mary Keohane, who attends and assists in the Eurekus classes every Wednesday afternoon. Mary works very closely with Monica and Tyler to plan each lesson, so that the STEAM activities are aligned to the science units of study. Further, Mary develops her own science lessons for second and third grade—she teaches each classroom once per week—to align with what students have been working on with Eurekus. For example, as students learn about the life cycle of frogs in their time with Eurekus, they are learning about other animals and similar concepts in their weekly science class.

Further, Eurekus collaborates with students' in-class teachers to link the STEAM program to their Expeditionary Learning units, aligning the program with NGSS standards and providing opportunities for literacy extensions. For an added layer of educational depth, Eurekus works with classroom teachers to have students use particular vocabulary words that they have been practicing in their literacy class, in both written and oral presentation. In the first year of implementation, the repetition of certain words proved an especially effective way to address the language needs of the many non-native English speakers in the group.

Centennial leadership is committed to continuing the partnership with Eurekus in the coming years, and will continue to set aside funds to facilitate it.

Outcomes

The Centennial/Eurekus partnership has yielded three very solid STEAM curricular units, which are now available to other educators via the Eurekus website. (Units available here:

http://www.eurekus.org/steam-curriculum/) For the first unit—Simple Machines—Centennial science teacher Mary Keohane conducted a pre/post assessment of student knowledge. The assessment asked the second graders in September and then again in December to identify the six simple machines in both picture and word form. While the class averaged only 34 percent correct in September, the same cohort of students scored an average of 83 percent correct 10 weeks later. Clearly, working on projects that incorporated these machines had a big impact on their learning.

Unfortunately, Centennial did not conduct general student surveys of student perceptions of their own change in STEM knowledge and engagement, but anecdotal evidence (not to mention the quality of the STEAM projects produced) indicates that students benefited enormously from their participation.

As further evidence of the quality of the Eurekus curricula, the organization was recently named a finalist in the national STEM Mentoring Awards competition organized by US 2020, a division of Citizen Schools. US 2020 has a mission to dramatically scale the number of STEM professionals mentoring and teaching students through hands-on projects, with a focus on serving communities that traditionally are underrepresented in STEM fields—girls, African-Americans and Latinos, and low-income children. Eurekus joined other winners at a White House ceremony to receive its award.

PROFILE 3

John Barry Elementary School

Meriden, Connecticut

FAST FACTS

Grades: K – 5

Enrollment: 500

Low-income population: 80%

Daily schedule: 7:50 – 4:00

On a brilliant day in mid-spring, 25 second graders walk slowly along the outside wall of their school, pencils and notebooks in hand. They are led by their teacher, Kelly Summa, who tells them, "Just write down what you observe about the flowers and other plants in the school yard." As they come upon a patch of small yellow and purple flowers, the children quickly sit down to record their observations. "Do you want us to write what we think about the flowers?" asks one eager student. "Not yet," Ms. Summa replies. "Today is just about observing, and you can write words or draw pictures. We need to take that step first in our science investigation before we can discuss *why* these plants are the way they are." The children continue along their observation trek for another half hour, filling their notebooks with detailed drawings and many descriptive terms that they proudly show their teacher.

This afternoon session is one of the weekly STEM-related enrichments that these second graders participate in, and Ms. Summa has become the lead STEM enrichment teacher for the younger grades. Her efforts, in partnership with the principal science teacher for the district, have been instrumental in leading Barry to integrate more science-oriented enrichments into their expanded schedule.

Program Basics

Students at Barry participate in STEM through the enrichment programming that was added in School Year 2013 – 14, when the school converted to an eight-hour day. On top of the science units and activities that they have as part of their core academic classes (about two hours per week), kindergarten through Grade 5 students participate in the STEM enrichments on a rotational basis. The primary grades (K – 2) have a session once per week for a semester, and the older grades (3 – 5) participate every day of the week in three-week cycles. The curriculum is implemented by a team of John Barry staff including teachers and community partners.

The STEM programming consists of four different modules that are aligned with grade-level science standards. Enrichment modules are mapped to complement the units students are studying in science class, which are, in turn, enhanced with engaging hands-on projects. These modules and units include:

- Engineering and Design
- Matter
    - Materials and uses of materials
    - Water cycle

- Force and Motion
  - Applying Newton's Laws of Motion
- Environmental Ecology
  - Climate
  - Adaptations
  - Ecosystems

The lessons and activities in these STEM enrichments focus on inquiry-based learning through the completion of particular projects and experiments.

Unit Highlight

The "Construction Zone" unit within the Engineering and Design module furnishes the students in Grades K – 2 with opportunities to design, plan and construct various shelters using a variety of materials. In the process, they tap into critical thinking skills by, first, comparing the properties of the materials using T charts and, second, by explaining their design and building plan before, during and after the building process. Design projects include using toothpicks and mini marshmallows to create a giraffe and building boats of aluminum foil that can float up to 100 pennies. Students are given a specific design challenge each week for seven weeks. In the course of building these models, some students are tasked with serving as engineers and others as contractors. Engineers need to communicate about their design, and contractors need to learn how to understand and execute on the design drawings. Students then switch roles, thus providing each set of students the chance to apply what they have learned from serving in the other capacity.

Barry second graders working proudly at their schoolyard Design Lab.

The Construction Zone unit draws its content and objectives from the NGSS standards, including:

- K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Partnership with the YMCA

John Barry Elementary engaged in the development of its STEM programming by partnering with the Meriden YMCA, which was a natural fit with the school. For starters, the YMCA had already been involved with John Barry for two years to provide enrichment opportunities (since the inception of ELT). Even more important, the YMCA has a STEM Academy, which hires local expert science educators—often, high school science teachers from nearby districts—to develop and run programming.

The YMCA STEM Academy has taken on three key roles as part of its partnership with Barry Elementary:

- Collaborating with both the school and district in developing a viable and robust enrichment curriculum;
- Facilitating STEM field trips which includes multiple hands-on and engaging activities; and
- Organizing a family STEM night at John Barry, enabling families to participate in variety of activities from launching air-powered rockets to operating robots.

Outcomes

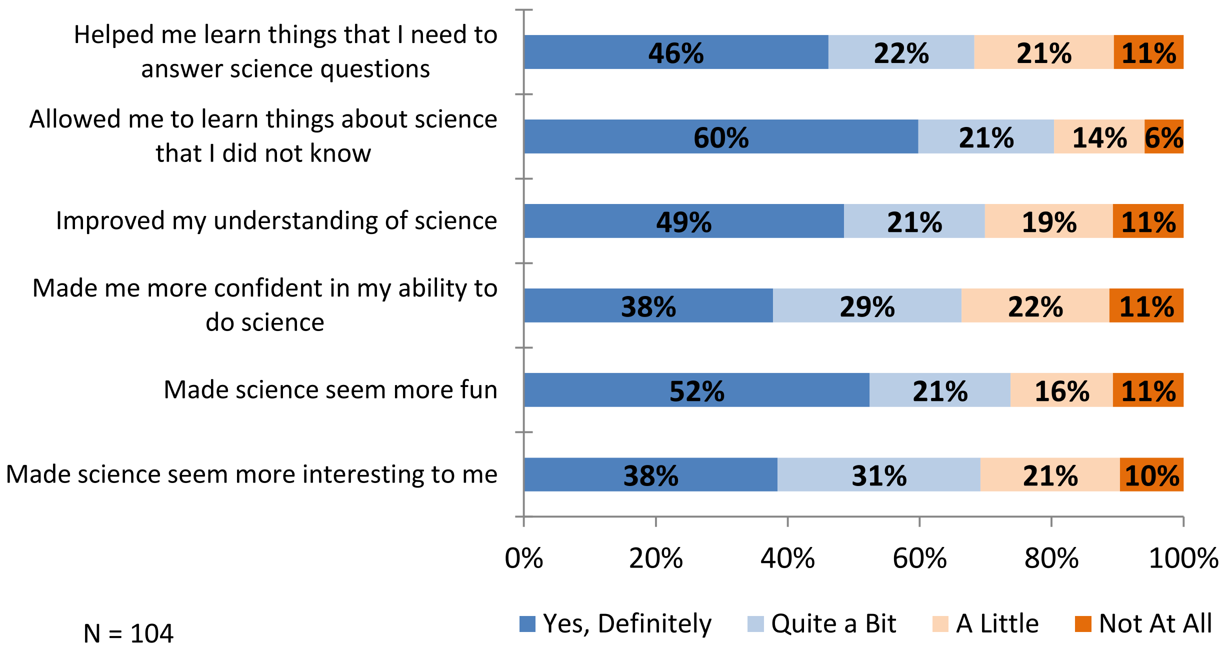
Anecdotal reports from teachers indicate that student engagement during the lessons was quite high and that students appeared to grow in their understanding of science and scientific concepts. Teachers also reported that they were successfully able to integrate literacy skills into the STEM programming, especially as students were asked to communicate ideas and draw conclusions about their observations and projects. Data from student surveys also reflect a high level of engagement and interest in the STEM enrichments. (See Figure 2.) One student summed up her takeaway: "Some of the best things in science lessons are that we actually get to experiment with the technology. We also observe and ask questions to learn more about the topic."

Students build complex structures to test forces and motion.

In addition to increasing student engagement and knowledge, a second significant outcome of the STEM work at the Barry has been the development a K–5 STEM curriculum, complete with four full units of study and grade-level appropriate lesson plans for each lesson with these units. Mary Jean Gianetti, the science specialist for the Meriden district, led the development of this curriculum. She has provided this curriculum to the other seven elementary schools in the district, each of which will then implement it in their own enrichment cycles.

Figure 2
Survey of Students Who Participated in STEM Enrichment Programming at Barry
Percent of Students Responding, May 2015

The STEM program…



N = 104

PROFILE 4

Escuela Bilingüe Pioneer Elementary

Lafayette, Colorado

FAST FACTS

Grades: PK – 5

Enrollment: 490

Low-income population: 50%

Daily schedule: 7:50 – 3:20
(80% of students participate in after-school enrichment)

Strange looking creatures made of old CDs, pipe cleaners, marbles and small motors dance on tables around the room, and the students are fascinated. "I added wings to mine to help balance it," says one student proudly watching his "jitterbug" rotate in tight circles around the tabletop. "Great idea," responds the teacher and, turning to another, asks, "And why did you add the marble to the center?" The student looks sheepish, "So when we have our jitterbugs fight each other mine would be more stable and win." "Clever!"

These fourth graders who, their teacher Sara Nelson admits, "can sometimes be a handful," are eagerly participating in their after-school activity known as "Maker's Club." Here, they have fashioned all manner of objects and toys using simple materials and a lot of ingenuity. Even though this club was not originally part of Pioneer's plan for the NCTL/Noyce project, it developed when teachers realized that they could take what they had developed for classroom work and adapt it to make a fun, engaging set of projects for students in their after-school setting. The result has been a synergistic dynamic where the STEM lessons in core academics have become more deliberately focused on project-based work, and the projects in Maker's Club are rooted in scientific principles and process.

Students celebrate their successful new jitterbug design.

Program Basics

Pioneer actually implemented two distinct STEM components as part of its work in the NCTL/Noyce network. The first part was the creation of a standards-based curriculum unit on electromagnetism for Grade 4. In addition to aligning the lessons and unit plan with the NGSS standards, the Pioneer teachers have also integrated them into what the school calls "Bilingual Unit Frameworks." Because the school has a full bilingual program—approximately half the classes are taught in Spanish, half in English, and students select the track they enroll in—it is essential that all curricula be adapted for Spanish speakers. In elementary education today, the availability of STEM standards-based resources in Spanish is rare, and so it is often incumbent upon Pioneer teachers to develop these from scratch.

The second strand of work involved the creation of an enrichment class called “Maker’s Club,” the brainchild of teacher Sara Nelson and her partner from the Denver Museum of Nature and Science, Gianna Sullivan. The projects in this club build off the principles that fourth graders learn in their core academic classes, but take an approach built on discovery, rather than adhering to a step-by-step procedure. Students work with a range of materials to design their own versions of devices and structures that test the principles they learn in class. Projects include the “jitterbug” (described above), crazy marble runs and rain sticks.

Unit Highlight

The fourth grade unit on electromagnetism served as the pilot for Pioneer’s re-invigorated work on STEM. Classroom teachers collaborated to figure out how to build lessons that were standards-based and would translate (literally) to the Spanish-track classes as well.

Fourth graders test their circuits and create new “connections.”

One of the signature activities of this unit is students’ work with “Squishy Circuits,” a combination of heavy-duty electronic components for use in schools with other soft conductive material. Students are given project objectives (e.g., to power a light bulb using certain components) and then time to experiment with the materials to see what works best and, importantly, to discuss why certain configurations work the way they do. The lesson objectives derive directly from two core NGSS standards on electromagnetism:

- PS3-2: Make observations and provide evidence that energy can be transferred from place to place by sound, light, heat, and electrical currents.
- PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Partnership with Denver Museum of Nature and Science

The Pioneer teachers who headed up the design and implementation of the STEM curriculum looked to the Denver Museum of Nature and Science (DMNS) as a guide for content and activities. DMNS also pointed the Pioneer team toward particular STEM hardware resources, like “Little Bits,” sturdy electronics components that students can use to experiment in the basics of circuitry, and websites like the *Exploratorium*. Gianna Sullivan, the main contact with DMNS, helped the Pioneer teachers to focus on depth, rather than breadth.

Pioneer also looked to the school community for assistance. One parent, for example, is a scientist and worked with lead teacher, Sara Nelson, to design the curriculum and structure of the Maker's Club. As Nelson explained, "It's one of the most valuable partnerships I've ever had because I can continually call on her for help. I will ask 'Is this how scientists would do it?' And then she'll walk me through what to do and what not to do. Her guidance has been invaluable." Another student's grandparent, a retired engineer, also spent time in the Maker's Club assisting students in their projects.

Outcomes

Pioneer staff working to infuse more hands-on STEM learning into the core academic classes admit that their original intent to try to do one unit per grade may have been too much to take on in a single year. Their early decision to focus instead on the fourth grade electromagnetism unit proved more successful. Another sound decision made early on was to use the afterschool Maker's Club as the "sandbox" to test out lessons and the ability of students to work with materials and apply concepts to their creations. Getting a taste of how to engage students in high-quality STEM learning outside the context of higher stakes academic classes gave Pioneer teachers and partner volunteers the space to test out the viability of making certain projects and, importantly, to gauge how well students were able to connect what they were doing to the concepts that they should be coming to understand.

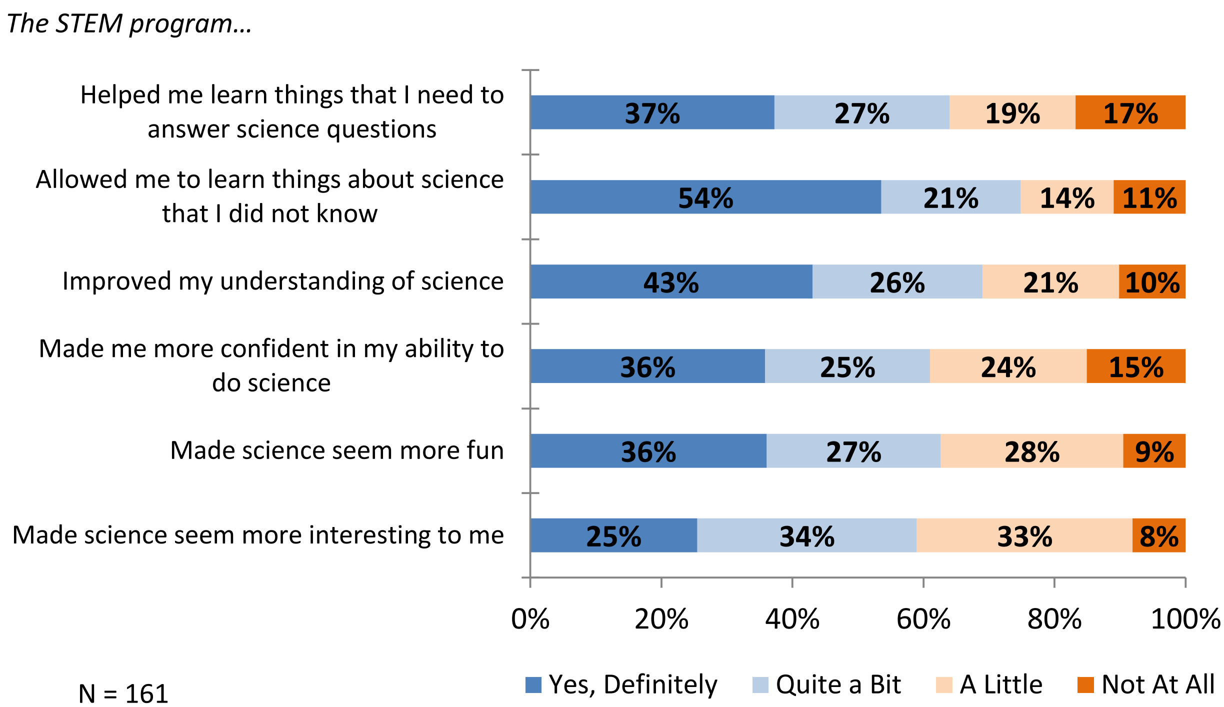
Lead teacher Sara Nelson assists a student in readjusting his new design.

In surveys, students largely agreed that participating in the STEM lessons helped them to deepen their comprehension and to excite them about learning science. (See Figure 3.) One student expressed an appreciation for the deep work that he has had the opportunity to do, "Some good things are that we get full explanations and get to do some fun experiments. Science is fun."

Figure 3

Survey of Students Who Participated in STEM Enrichment Programming at Pioneer

Percent of Students Responding, May 2015



PROFILE 5

A.C. Whelan Elementary

Revere, Massachusetts

FAST FACTS

Grades: K – 5

Enrollment: 700

Low-income population: 39%

Daily schedule: 7:

"And why do the different materials make different sounds?" asks the classroom teacher, standing by a group of fourth graders. They had just recorded their observations about the sounds created by rubberbands wrapped in different materials strung around a shoebox. "Because of the vibrations," one student responds. "What do you mean exactly?" the teacher presses. "Well, for the one wrapped in foil, the rubber band is able to vibrate more and so the sound it makes is louder. The rubber band wrapped in clay can't vibrate at all and so the sound is muffled." "Exactly. Now be sure to write down your observations because we'll need that for the next experiment we do."

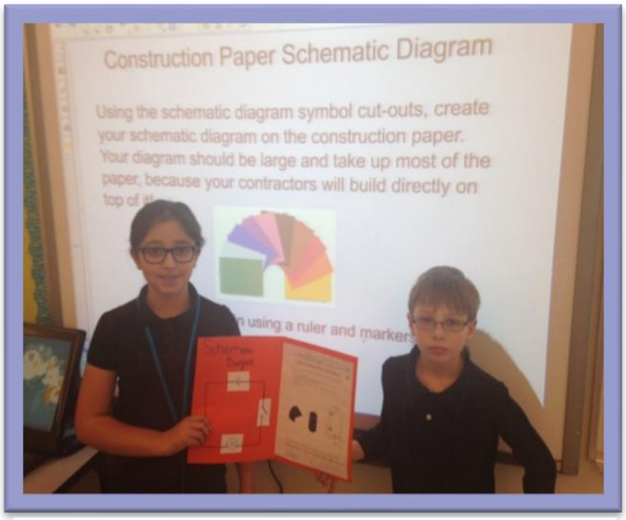
These students are getting the chance to engage with the Engineering is Elementary (EiE) curriculum, a set of NGSS-aligned lessons produced by the Boston Science Museum specifically for elementary students. EiE has become integrated into the science classes of the fourth and fifth grades, taught by the regular classroom math and science teachers. (Fourth and fifth grades at Whelan are departmentalized.) Whelan administrators and faculty have adopted this curricular innovation because an analysis of the fifth grade state science assessment (MCAS) data revealed that students struggled most with questions rooted in engineering concepts. Adopting one of the premier curricula in engineering—and one that simultaneously helps to develop students' math and literacy skills—seemed like a natural turn. Further, EiE has been developed with a particular focus on helping especially girls, minorities, and other underrepresented groups, recognize their ability to engineer.

Program Basics

As committed as Whelan educators were to implementing the EiE curriculum, they also recognized that the teachers themselves did not feel fully comfortable leading such instruction not only because they were not familiar with the particular curricular approach of EiE, but also because engineering concepts were outside their expertise.

Students build circuits and record their observations about what works and does not.

The solution to closing this capacity gap was to contract with an expert in the EiE curriculum to train teachers how to deliver quality instruction and help ensure student growth. Once teachers were adequately and properly trained, they would then be able to integrate the entire EiE curriculum—not only the specific units for which they were supervised—into the fourth and fifth grade science classes going forward.



Students show off their latest schematic design.

In this first year, the teachers taught three units:

- Designing alarm circuits
- Sound engineering
- Ancient stone carvings

Each unit comes from EiE as a kit with a number of individual lessons and projects that each revolve around the main theme of the unit. To ensure continuity of learning, Whelan educators decided to run each unit daily for 45 minutes for an entire month.

Unit Highlight

The first unit that the Whelan teachers took on is entitled, "An Alarming Idea: Designing Alarm Circuits." The unit contains a number of lessons, including:

- Technology in a Bag – A hands-on activity to develop definitions of *technology* and *engineer*; student will be able to apply insights about technology and engineering to solve a problem
- It's Electric – A scavenger hunt to identify the electrical technologies used in a given day; students will be able to sort identified technologies by function, and relate their discoveries to energy transformation
- Representing Circuits – Using schematic diagrams to explain standardized symbol systems; students will be able to create schematic diagrams of circuits, and identify closed and open circuits
- Designing An Alarm Circuit – Following the steps of the Engineer Design Process to design an alarm circuit; students will be able to create a schematic diagram, build a circuit from the diagram, and improve original designs

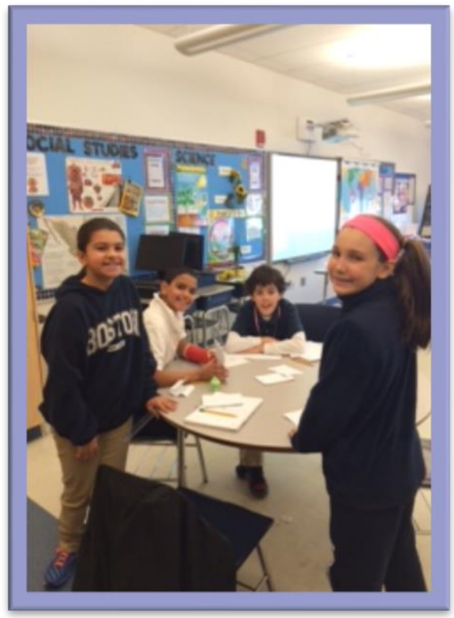
The sequence of lessons touches on many of the NGSS standards, including:

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

Partnership with Blue Heron STEM

When Whelan decided to pursue professional development training for the implementation of the EiE curriculum, adminstrators consulted with the Boston Museum of Science as to the best options available. The museum recommended connecting with one of the original designers of the curriculum, who now runs an independent firm dedicated to providing professional development to teachers. Thus, the partnership with Carolyn DiCristofano, founder of Blue Heron STEM, was born.



Students work together to solve the engineering problem presented in "Technology in a Bag."

Blue Heron has combined teacher training and co-teaching with support for cooperative lesson planning, committing over 20 hours over the course of four months. Further, Blue Heron instructors have provided observation and feedback to Whelan teachers, which included collecting data on student learning to inform future instruction.

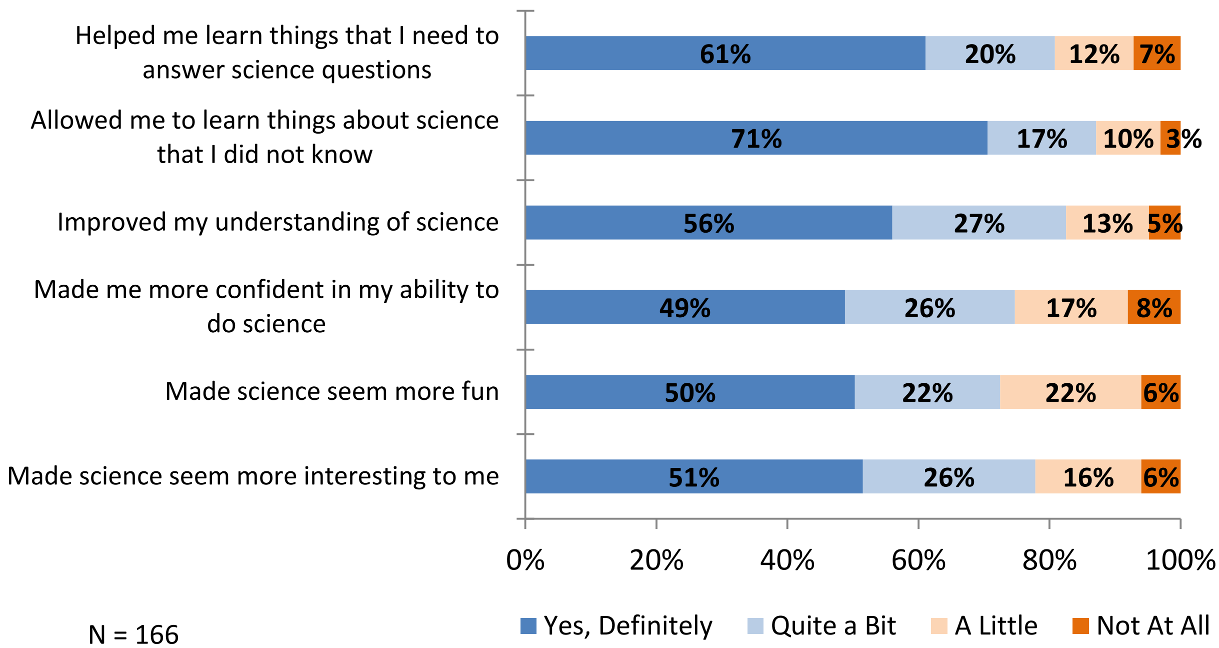
The partnership has been so productive that Whelan has sought ways to continue the relationship beyond the life of the NCTL/Noyce grant.

Outcomes

The success of the Blue Heron/Whelan collaboration in their first year operated on two levels. First, the professional development provided to teachers had a significantly positive impact on the teachers themselves, as they perceived the training to be highly effective. For example, they felt that the opportunity to play the role of student and engage fully in the unit during the training enabled an authentic experience which teachers were able to pass on to students. Further, this professional development was decidedly not like the standalone sessions that often characterize it. With Blue Heron, teachers integrated the training into their already existing collaboration structures, including common planning, vertical teaming and a dedicated Friday professional development block.

Of course, the more significant impact was on the students themselves who, surveys showed, were overwhelmingly positive about their learning during the EiE units. (See Figure 4.) In particular, the students demonstrated a clearer understanding of the way in which science is conducted. As one student noted, "I really like to do experiments. Even though sometimes I don't do it right, they always teach me something no matter what. Also, the experiments are best when we cooperate with each other."

Figure 4
Survey of Fourth and Fifth Grade Students at Whelan
Percent of Students Responding, May 2015



N = 166

Conclusion

Lessons Learned

As the profiles of each site illustrate, these schools and partners were able to make significant strides in providing high-quality STEM education for over 1,200 children. Perhaps more impressive, this progress sprung from relatively modest resources: a small planning grant and a few hours of well-placed coaching and technical assistance. Though the educators at these sites recognize they are only just beginning to achieve their objectives—both in terms of number of students served and in the depth and breadth of programming—each has laid out a clear path towards attaining such objectives. Conditions now in place include: a strong partnership with an external expert, a clear vision of what STEM lessons and units can and should be, a cohort of educators committed to implementation, a process for continuous improvement and, in some cases, a solid funding source for continued expansion. In this way, the five sites in this demonstration project met the high expectations for planning and implementation held by both the Noyce Foundation and the National Center on Time & Learning. In short, our investment has been an overwhelmingly successful one.

Now that the project has run to its conclusion, we are able to reflect on some factors that helped to drive this success, as well as to consider those areas where the project could have been improved. The following list is not exhaustive, but intended to spark thinking about how to assure future endeavors of this type also meet with success.

1. **Set high standards up front** – One of the problems this demonstration project sought to address was the dearth of opportunity available for STEM education in elementary schools and, thus, we could have settled for supporting programs that merely increased the time spent on STEM. But we were also focused equally on the second weakness in STEM education: quality. Too frequently, there is a large gap between the ideal STEM learning environment (as encapsulated in the Next Generation Science Standards) and actual practice. Thus, throughout this project we insisted on improving educational quality, as well. From the outset, we made it clear to potential grantees through the RFP that we were seeking the implementation of top-notch programming that aligned to NGSS and, further, that leveraged increased time to bolster the quality of education put in place. These high expectations also extended to the range of activities required of sites for a fairly small grant ($12,000). These activities included: (a) producing a full implementation plan; (b) development of curriculum that revolved around inquiry-based activities; (c) attendance at three technical assistance trainings, usually necessitating long distance travel and overnight stays; (d) arranging for and being responsive to on-site coaching; and (e) consistently reporting on program planning and implementation.

2. **Choose grantees wisely** – The five sites selected for participation in this project each made plain through their responses to the RFP that they understood well the core elements of the model: filling a demonstrated need for better and more STEM education, building a robust partnership, showing a commitment to creating new programming, and developing a clear plan for how to implement such programming. NCTL and the selection committee identified schools and science partners carefully through a detailed request for proposal process that tried to assess each site's readiness to engage in the proposed work. Because the schools that applied were part of NCTL's network, we knew them well and were able to consider their commitment to the project in our selection process.

3. **Empower educators** – As focused as Noyce and NCTL were on catalyzing quality STEM education by using external expert partners, neither the content nor structure of this partnership were prescribed. Rather, we encouraged educators to present and prove their model for bringing quality STEM education to students. The relatively broad directive resulted, as evidenced by the five profiles, in very different approaches. Some saw a better fit of an activity-based curriculum within the enrichment block, while others sought to bring such methods into core academic science classes. Some program educators hailed from the external partner, others relied on full-time teachers. In designing their programs, some educators chose to work with younger students, others with upper elementary grades, and one with the full range. By setting up the project such that educators would be working to develop their own programs, rather than figuring out how to implement an externally mandated one, the grant helped to assure a greater degree of dedication to solid outcomes. The downside of this approach was that some educators, lacking a clear roadmap, struggled somewhat to move from idea to implementation. They found it necessary to scale back their original objectives or readjust the scope of the partnership. Still, even if a particular site faced setbacks, teachers and administrators continued to demonstrate motivation to persist through to solutions specifically because they were committed to their wholly-owned vision.

4. **Guide educators toward quality execution** – Even as the project revolved around ensuring site-level autonomy, NCTL coaches and technical assistance sessions held the level of quality expected from both the plan and the logistics of the partnership to a consistent standard. This standard was set first through the three technical assistance sessions where NGSS was featured prominently, as was the process sites should be undertaking to help ensure that both school and partner delineated roles and responsibilities. Further, the on-site coaches, who visited each site about once per month, provided pointed, yet supportive, feedback to faculty and administrators as they worked through logistical challenges. Coaches also facilitated the development of curricula by helping educators to focus on how specific lessons did (or did not) meet NGSS expectations.

5. **Insist upon continuous improvement** – In addition to holding up NGSS as the expectation for educational content, NCTL also developed and promoted clear expectations for a range of other program elements, including the partnership, educational setting and family engagement. Having set these measures of quality—and, further, encouraging schools to continually seek to improve upon how well they measured up to them—helped to concretize the process. That is, rather than flatly asserting that schools "improve," this rubric offered educators specifics on *how* to improve.

Further, providing sites tools for measuring both student engagement and learning and teacher perception of student learning, sites had some data with which they might better understand their impact and where it could grow.

We very much look forward to applying these lessons to future opportunities to identify and support other expanded-time schools that can also build robust and replicable models of STEM education. With a growing field and a clear need, we believe that the demonstration project provides a solid foundation on which to build.

A Final Thought

At the third technical assistance session, which was held at MIT's Media Lab, STEM educators had the rare opportunity to get a behind-the-scenes look at the incredible work taking place at one of America's premier innovation laboratories. They interacted with life-like robots, observed 3-D cities being constructed in real time, and even stepped into a model apartment with "smart furniture" that adjusted position and function depending on the time of day. Reflecting on the experience, one teacher spoke what many were thinking: "We're preparing our students for jobs that don't even exist yet." These teachers, charged with educating the next generation of innovators and thinkers, left feeling both humbled by the mind-bending application of science and technology they had witnessed and inspired to return to their students and lead them to harness their own curiosity and creativity toward solving complex scientific problems. They wanted their students, too, to help shape the future.

NCTL and Noyce are proud to have been able to furnish the platform on which this inspiration might take off and, further, to have proven that the field of expanded-time schools is ripe for capitalizing on the opportunities more time affords. Indeed, the progress the five sites in the demonstration project have made testifies to three core realities: (a) the readiness of ELT schools to engage in the work of improving upon their STEM education, (b) the ability of external STEM experts to boost schools' capacity in developing and delivering innovative programming, and (c) the high value of catalyzing these partnerships through modest grant resources and coaching. If we are to meet the challenge of furnishing today's students with the experiences, the skills and the habits of mind they will need to become the next generation of scientists, engineers and innovators, we must commit to turning these types of expanded learning opportunities from the exception to the norm. The jobs of the future are calling.

APPENDIX A

The Six Strands of STEM

Strand	What This Means for Students
Sparking and Developing Interest and Excitement	✓ Focus on the motivation to learn science, emotional engagement, curiosity, and willingness to persevere through complicated scientific ideas and procedures ✓ Engagement can trigger motivation to seek out other ways to learn more about a topic
Understanding Scientific Knowledge (content)	✓ Knowing, using, and interpreting scientific explanations of the natural world ✓ Understand interrelations among central scientific concepts and how to use them to build and critique scientific arguments ✓ Focus on concepts and link between them rather than discrete facts; application of knowledge is key
Engaging in Scientific Explanation and Argument	✓ Developing knowledge and skills needed to build and refine models and explanations, design and analyze investigations, and construct and defend arguments with evidence ✓ Recognition of instances when insufficient evidence to draw a conclusion and determining what kind of additional data are needed
Understanding the Scientific Enterprise	✓ Focus on science as a dynamic process, based on the continual evaluation of new evidence and the re-assessment of old ideas ✓ Understanding science as a way of knowing as a social enterprise that advances scientific understanding over time ✓ Appreciating how the thinking of scientists and scientific communities changes over time as well as the learners' sense of how his or her own thinking changes
Engaging in Scientific Practices - Using the Tools and Language of Science	✓ Seeing science as a social process, in which people with knowledge of the language, tools, and core values of the community come together to achieve a greater understanding of a scientific problem ✓ Engaging in scientific activities to develop greater facility with the language of scientists
Identifying with the Scientific Enterprise	✓ Seeing oneself as a scientist, as someone who can “do science”

APPENDIX B

STEM Program Quality Diagnostic

The following diagnostic is intended for STEM programs to assess their own status along a number of key expectations for operating quality STEM programming in partnership with an external technical assistance or content provider. The assessment tool can also be used by observers seeking to identify program strengths and areas for improvement. In either case, this tool is not intended to be evaluative, but a core component of a continuous improvement process.

Scoring Rubric

L = Lacking	No evidence or significant lack of evidence of implementation
E = Emerging	Little or inconsistent evidence and/or implementation throughout the school
P = Proficient	Consistent level of evidence and/or implementation throughout the school
X = Exemplary	Proficient plus: • Creative or original solutions, strategies, or practices • Would serve as a model for others to emulate

Expectation	Indicators of Meeting Expectation	Rating
The classroom environment and culture effectively support STEM learning.	Staff and students have access to resources, equipment and supplies that support STEM learning.	
	There is an adequate amount of STEM materials for all students to participate.	
	STEM materials are age- and developmentally-appropriate.	
	Materials are well-maintained, safe, and used appropriately.	
	Students are encouraged to discover, explore, experiment and take risks.	
	The classroom space is arranged to maximize exploration and project-based work.	
	Students have positive relationships with instructor(s) and are consistently supported in constructive ways.	
Individual lessons and the curriculum as a whole are scientifically rigorous and provide ample opportunities for students to learn and demonstrate STEM content and skills.	Activities are aligned with Next Generation Science Standards and/or district curriculum frameworks.	
	Students engage in scientific practices and use the tools and language of science (e.g. making and testing hypotheses, collecting and analyzing data, etc).	
	Students learn about and demonstrate an understanding of scientific concepts, facts and explanations.	
	Students learn to construct, critique and defend scientific arguments.	
	Students use scientific vocabulary and apply scientific concepts to express their ideas and findings.	
	Students learn about and demonstrate an understanding of interrelations among central scientific concepts.	
	Lessons build on students' prior knowledge and skills.	
Individual lessons and the curriculum as a whole inspire and engage students in STEM learning.	Activities spark student's interest in science and the scientific process.	
	Students are actively engaged in creating, experimenting, observing, and analyzing.	
	Limited disruptive behavior displayed by students.	
	Students collaborate with their peers to advance their work.	
	Students have some ability within the program structure to identify topics and questions of interest to explore and/or topics connect to student interests and experiences.	
	Students have opportunities to practice new skills, present, and showcase their work to each other and/or to others.	
The program effectively engages families and the community, and rests upon a constructive partnership between the school and external partner.	Students (and families) have the opportunity to use resources or facilities managed by the partner org.	
	The program engages families in a variety of ways (e.g., family science nights, sending home materials and/or projects, etc.).	
	The school and partner have a memorandum of understanding to delineate roles and responsibilities.	
	School and partner staff collaborate on the planning and/or delivery of lessons/units.	
	The school and partner meet regularly to share challenges and solve problems collaboratively.	

Teachers and partner staff prepare and deliver high-quality lessons, and receive professional development that increases their confidence and ability to facilitate quality STEM learning.	Teachers and/or community partners prepare detailed lessons plans with clear learning objectives and adhere to them.	
	Teachers and/or community partners demonstrate a solid understanding of the scientific concepts they are teaching.	
	Teachers have adequate time to prepare for class including collaborating with peers and partners.	
	Teachers and/or community partners learn to use the inquiry process and other methods fundamental to the teaching of STEM.	
	Teachers and/or community partners engage in regular professional development to hone their knowledge and skills.	
	Teachers and/or community partners demonstrate understanding of how to align STEM lessons with school-wide instructional focus and practices.	
Teachers and program staff continually strive to improve instruction by utilizing a variety of data to measure the impact of its STEM programming.	The program collects data from staff, students, partners and parents to gauge students' STEM learning.	
	Individual lessons and/or the curriculum as a whole are adjusted based on data findings and teachers/administrators demonstrate a commitment to continuous improvement.	
	The program shares the progress outcomes with key stakeholders.	

Acknowledgements: This diagnostic instrument draws much of its content from the *Indiana Afterschool Specialty Standards: STEM* (2012) prepared by the Indiana Afterschool Network. In addition, characteristics of scientific rigor and engagement are drawn from Fenichel, M. & Schweingruber, H.A. (2010). *Surrounded by science: Learning science in informal environments*. Washington, D.C.: National Academy Press.

APPENDIX C

Student Survey Responses

By School

	Pioneer				Whelan				Barry			
The STEM program…	Yes, Defi-nitely	Quite a Bit	A Little	Not at All	Yes, Defi-nitely	Quite a Bit	A Little	Not at All	Yes, Defi-nitely	Quite a Bit	A Little	Not at All
Made science seem more interesting to me.	25%	34%	33%	8%	51%	26%	16%	6%	38%	31%	21%	10%
Made me more excited about science.	26%	25%	33%	16%	47%	30%	16%	7%	49%	22%	17%	13%
Made me more interested in a science job when I am older.	21%	15%	33%	31%	19%	18%	33%	30%	20%	14%	25%	41%
Made science seem more fun.	36%	27%	28%	9%	50%	22%	22%	6%	52%	21%	16%	11%
Made me feel more sure that I want a job in science when I am older.	16%	11%	32%	40%	11%	19%	23%	46%	16%	17%	18%	50%
Made me feel more relaxed about learning science.	24%	27%	30%	19%	31%	30%	22%	17%	41%	24%	19%	16%
Made me more confident in my ability to do science.	36%	25%	24%	15%	49%	26%	17%	8%	38%	29%	22%	11%
Made me feel better about myself as a science student.	37%	23%	23%	18%	44%	27%	17%	12%	43%	17%	20%	21%
Made the idea of a job in science when I am older see more possible.	25%	21%	25%	30%	20%	24%	31%	24%	18%	25%	19%	38%
Made me more confident that I could do well in science classes in high school.	34%	30%	24%	13%	50%	26%	16%	8%	48%	20%	17%	14%
Improved my understanding of science.	43%	26%	21%	10%	56%	27%	13%	5%	49%	21%	19%	11%
Allowed me to learn things about science that I did not know before.	54%	21%	14%	11%	71%	17%	10%	3%	60%	21%	14%	6%
Gave me experience that will help me in the future with science projects and activities.	37%	25%	21%	17%	60%	23%	13%	4%	44%	25%	17%	15%
Helped me know what science is.	41%	20%	19%	20%	51%	22%	13%	14%	61%	23%	11%	5%
Helped me learn things that I need to answer science questions.	37%	27%	19%	17%	61%	20%	12%	7%	46%	22%	21%	11%