Investigating the Implementation of the Be A Scientist! Project in New York City and Los Angeles

Formative Evaluation—Year Three

EDC Learning transforms lives.

Prepared by Harouna Ba at EDC's Center for Children and Technology

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INTRODUCTION

Iridescent—a nonprofit afterschool science, technology, engineering, and mathematics (STEM) program (www.iridescentlearning.org)—manages the Be A Scientist! (BAS) project. The goal of Iridescent's five-year BAS project is to provide high-quality afterschool science and engineering courses to underserved families in New York City (NYC) and Los Angeles (LA). The project aims to enable participants to develop a deeper understanding of scientific practice through interaction with innovative and scalable STEM educational approaches. In spring 2013, the program specifically targeted third graders and their families, though siblings and family members of all ages were welcome to attend. To implement the spring program, Iridescent worked with eight schools, one museum, parent leaders, and two university partners in LA and two schools, one museum, and one university partner in NYC (see Appendix).

Research Context

EDC's Center for Children and Technology (CCT), a nonprofit research and development organization (cct.edc.org), conducted the formative evaluation of the BAS project for the last three years. Iridescent has assisted CCT researchers in the successful implementation of the evaluation (e.g., organizing site visits and meetings with partners, administering surveys, collecting consent forms). As discussed in more details below, Iridescent has always taken seriously the evaluation findings and recommendations, and has acted upon them to make program improvements. This research partnership has led to the design and development of a more responsive evaluation approach centered on successes and challenges encountered during the implementation of the project at multiple sites and with various partners, participants' experiences of the BAS project, the project's impact on participants, and suggested program improvements.

Research Questions

CCT researchers used the following research questions to guide this year's formative evaluation:

1. Are the development and implementation of project materials, recruitment strategies, training, and course activities well designed and integrated into the project's goals?
2. How do participants experience the project?
3. What is the impact of the project on families, undergraduate engineering students, and project partners (e.g., universities, museums)?
4. What are the programmatic and strategic recommendations for improvement of the project?

METHODOLOGIES

To answer these questions, CCT researchers employed a multi-method research approach, using surveys, interviews, and site visits. The research instruments addressed four themes: families' profiles and educational expectations, implementation success, implementation challenges, and impact on participants. In addition, the student survey asked participants to draw a picture of their favorite building/construction activity and describe what is happening in the picture, and to imagine and draw an engineer at work.

CCT researchers surveyed the Engineers as Teachers (EasT) undergraduate students (pre- and post-surveys) and families, conducted site visits and observations in NYC and LA, and interviewed project staff and program partners. All surveys and consent forms were made available in English and Spanish. For the NYC parents, the surveys were made available online because they did not fill them out at the end of the session.

CCT researchers conducted three observations of Family Science courses and interviewed eight Iridescent staff, eight individuals from the three partnering organizations, twenty undergraduate engineers, five children, and four parents. Twenty-two undergraduate students (response rate = 69%), 90 parents (response rate = 46%), and 137 children (response rate = 49%) responded to the post-surveys. Only one student from New York City responded to the survey, and NYC parents did not participate in the survey study. In addition, CCT researchers conducted two site visits: one in LA, and one at the New York Hall of Science (see Table 1).

Table 1: Study Participants and Sites

Participants & Sites	Interviews	Observations	Surveys (response rate)	Sites
Parents	4	--	90 (46%)	--
Undergraduates	20	--	22 (69%)	--
Children	5	--	137 (49%)	--
Partners	3	--	--	--
Iridescent staff	8	--	--	--
Los Angeles	--	2	--	1
New York City	--	1	--	1

In addition, CCT researchers collected relevant project documents (e.g., meeting notes, videos, course syllabi, descriptions of new program components) and held regular meetings with the project's staff. They worked collaboratively with BAS staff to implement the evaluation, and reviewed what action was taken by Iridescent with regard to recommendations contained in the Year Two formative evaluation report.

CCT researchers used both quantitative and qualitative data analysis methods to analyze the data collected. For quantitative data (e.g., surveys), they used SPSS, a statistical software tool, to conduct descriptive data analyses. They read and coded the interviews, observation data, and drawings to identify the salience and substance of themes that surfaced around the project's implementation, impact, and challenges. They reviewed relevant documents to inform the program implementation processes.

RESULTS: EXPERIENCES and IMPACT

As the BAS project has grown, it has become more responsive to families' STEM educational needs than in previous years. It has refined its support infrastructure and made it more sustainable, and has encouraged parents and communities to take ownership in the local implementation of the project. Iridescent has been very responsive to the Year Two evaluation recommendations, addressing 25 out of the 32 recommendations for program improvements (78%) in the domains of family recruitment and retention, program management, training and program structure, partnerships, and Engineers as Teachers Course. As a result, it continues to have a positive impact on the EasT students, parents, and children.

Improved Key Program Components for Long-term Sustainability

Iridescent has been very responsive to the Year Two evaluation recommendations, addressing 25 out of the 32 recommendations for program improvements (78%) in the domains of family recruitment and retention, program management, training and program structure, partnerships, and Engineers as Teachers Course. Key programmatic components were successful this year: program management, partnership with the Natural History Museum of Los Angeles, and EasT course and Family Science.

Improved Program Management. Iridescent's first critical action was to convene three stakeholder meetings to discuss how to address the Year Two recommendations and plan for program improvements. In addition to project staff and project partners, school administrators attended the meetings. Further, Iridescent staff met with school administrators at all sites and ensured they were more aware of the project's goals and objectives.

To improve the recruitment and retention of families and to alleviate Iridescent staff's management responsibilities, Iridescent adopted several interrelated and complementary programmatic strategies. They transferred the reminder phone call task to school staff or parent leaders (see Appendix for a description of the Parent Leaders Program). This first action afforded a decrease of families' dependence on program staff to attend classes. Second, they worked with parent leaders at a select group of schools to collect data about families' reasons for leaving the program. Third, they created multiple design challenge levels in the Family Science (FS) course to give families an incentive to come back. The challenges added variety and interest for families by motivating them to complete each challenge level and redesign their project to meet the new challenge. Fourth, they exported data from the current database and created queries and reports with data by school to look at retention issues at each school, and developed localized retention strategies. The Iridescent team shared data with school staff and developed retention strategies using this data.

As a result of this pilot leadership program in LA, there were positive correlations between engaged parent leaders and strongest levels of families' attendance and retention. For example, two of the schools (Placencia, Synergy) had high retention rates, according to the Parent Leader Coordinator. Similar results were found in NYC at one of the schools where the parent coordinator is involved in Iridescent: Attendance was high and consistent over a five-week period. Similar attendance and retention rates were observed at NYSci.

Iridescent encountered challenges in the implementation of its keytag system, used to monitor attendance at FS nights. According to Iridescent staff, there are too many steps involved in collecting data with the system and too many system errors. The system was down in the third week of Family Science. In addition, Iridescent had difficulties querying the attendance because they discovered that the database was not functional and was not easy to use for data analysis. Also, some families lost their keytags and had to redo the paperwork. This situation resulted in the lack of consistent and reliable data about families' attendance and retention, and the realization that the keytag system is not scalable.

Improved Partnership with the Natural History Museum. The partnership with the Natural History Museum was a total success in integrating the two programs and getting families engaged throughout the five-week course. The partnership between staff at the Natural History Museum and Iridescent has improved drastically for several reasons, including increased involvement of museum staff in informing the content of FS sessions, holding planning meetings with museum staff, deciding to use EasT alumni as instructors, and using MetroCards for museum-paid family transportation instead of relying on private buses to pick up families at specific locations. In consultation with Iridescent, the museum plans to invite another BAS school to participate next year. In addition, the BAS coordinator at the museum attended the fall EasT course and gave a workshop on learning from images. The EasT instructors who participated in the fall course met regularly with NHM staff in the spring to create engineering activities based on the museum content.

Developed Basic Automated System for Monitoring and Improving Instructional Practices. The USC Engineering Graduate Students and their adviser, who is a co-principal investigator (Co/PI) on the BAS project, continue to improve the development of a system of automated codes of best instructional practices. They are still in the process of refining the coding program in terms of student engagement or lack of engagement during the Family Science instruction and helping EasT students to refine their instructional practices.

Last year the USC team focused on "training machine learning algorithms to detect events of interest to instructors in videos of informal classroom settings." They spent time conducting data collection, creating data analysis codes in systematic ways, and using videos to annotate the data with Iridescent staff. The data was annotated using codes of engagement and disengagement behaviors in Family Science classroom settings. They completed 67 annotations and used the data to train their algorithm about engagement and disengagement. They created methodologies to track the information on the videos and found six major components of engagement and disengagement behaviors, including children's interaction with EasT instructors and volunteers, participating in class by raising hands/asking questions, and lack of attention to instruction.

To refine the tool, they are training their algorithms to identify sudden behavioral changes in the videos or the lack of behavioral changes for a long duration. In addition, they are working on scale-up, planning to involve humans in the loop of machine learning to provide feedback, making it accessible in real time to assist FS instructors, investigating the factors associated with an efficient learning process, and building the space in ways aligned with the project's objectives.

Although they have made improvements, presented the tool at a conference, and received valuable feedback about how to improve it, the pace of the development of this tool has been very slow in the face of rapid programmatic development in the FS program. FS has reconfigured itself in the last three years. As a result, Iridescent staff are starting to question the future usefulness and relevance of the tool in the new educational configuration of the FS program.

Increased Focus of the EasT Program. This year's EasT program in LA was focused on a rigorous engineering design education and the development and implementation of multiple design challenge levels for FS nights. Iridescent staff trained the EasT students using a more stable training model focused on the development of better STEM communication skills, engineering concepts, and design skills. They offered a 16-week training about how to communicate complex scientific concepts to children and how to develop lesson plans and design challenges.

EasT had multiple sources of feedback and support during the course and FS nights. This year Iridescent provided more follow-up, structured feedback, and positive reinforcement for the USC undergraduate engineers as they moved through the course. During practice presentations in class, some of the students participated in peer review of their fellow classmates' presentations. The EasT instructor invited three EasT alumni to share their feedback and strategies with the rest of the class to assist newly recruited EasT students to get a jump-start on designing their curriculum and thinking through their teaching approach. They were given the opportunity to practice their lessons in front of high-school students from the Iridescent Explainers program before starting their first FS night and were provided guidance on how to create effective presentations, including the use of high-resolution images, limiting text, and using text in Spanish when possible. When using videos and animation in their presentations, they were advised to play them on "mute" and to narrate themselves, and then to replay them to allow for translation.

The instructor and TA attended at least one FS session, provided detailed feedback, and discussed the session with the students. During each course that followed a Family Science session, the first part of the class was devoted to personal reflections from students and a chance for them to ask questions.

EasT Students

Twenty-nine undergraduate students—most of them male and majoring in mechanical engineering—participated in the EasT program: one senior student from Cooper Union in New York City, and 27 students from USC in Los Angeles (see Table 2). Iridescent staff had difficulties recruiting undergraduates in New York City. It was both an intense recruitment effort and a frustrating recruitment process for the project manager in New York. She reached out to students atFordham and Columbia, and had 14 students signed up, but had only two students express interest in participating in the project. The undergraduate student in New York City who taught FS at NYSci and the two students who taught Family Science at MNH were alumni of the program and were remunerated for teaching the FS sessions.

Table 2: Number of EasT Students and Courses

Sites	Number of EasT Courses	Number of Trained Undergraduates	Number of Family Science Topics
New York City	5	1 (Male)	5
Los Angeles	15	28 (Male=21, Female=7)	12
Total	**20**	**29**	**17**

The EasT students were engaged and interested in participating in the course. They learned how to create lesson plans, improved their communication and presentation skills, felt more confident in speaking in public and to diverse audiences, gained a better understanding of creating successful engineering design challenges, enjoyed contributing to the local community, and sharpened their understanding of key engineering concepts. They enjoyed going to the school sites and creating prototypes. They indicated that they would recommend the EasT undergraduate class to peers (100%) and agreed that they feel proficient teaching complex science ideas to a non-scientist audience and working with children (100%), working with professionals outside their normal class schedule (95%), and speaking in public (95%). The quotes below illustrate the positive impact of the project on them.

> "I gained confidence speaking in front of big crowds of people. Additionally, I reinforced my scientific learning by having to explain complicated topics as simple demos so families and students understood."

> "I learned how to apply engineering concepts to teaching science to elementary students."

> "I gained a sense of satisfaction because I was able to share my love of science and design with young children who might otherwise not have been exposed to STEM in a fun environment. I also improved my public speaking skills and ability to describe scientific concepts in everyday language."

> “ ‘Soft skills' that I am not exposed to in any of my other engineering classes. These skills include public speaking, working with people who come from different backgrounds, and being able to explain technical content to people without technical backgrounds.”

Despite these successes, most of the undergraduate engineering students reported that they had challenges in coming up with and creating relevant, interesting, age-appropriate, and working experiments for 3rd-grade students. One of the undergraduate engineering students summarized the situation in the following way: “The most challenging part of this class was creating design challenges that effectively went with the concepts being presented, were challenging enough for students of the specified grade level, required re-design, and could be accomplished in the allotted time period.” While in the field they faced various challenges, including keeping participants interested in the lessons, understanding the concepts being taught, and coming up with a strategy when things did not work as planned.

Family Science as a Program

Families are recipients of the BAS project via the programmatic work and efforts of Iridescent staff and project partners. The section below addresses how the families experienced the project and how it impacted their STEM attitudes and knowledge.

There were 275 children and 197 parents that participated during the spring 2013 session (see Appendix). There were more females than males in the two groups and at both sites: 75% and 59% female adults, respectively, in LA and NYC sites, and 58% and 62% girls, respectively, at the LA and NYC sites (see Table 3).

Table 3: Number of Sites and Participants

Sites	Parents	Children
Los Angeles	168 (Female=75%, Male=25%)	254 (Female=58%, Male=42%)
New York City	29 (Female=59%, Male=41%)	21 (Female=62%, Male=38%)
Total	**197**	**275**

Unsurprisingly, most of the families heard about the BAS program from their child’s school (83%). (The program was run entirely in school this year.) Most families joined the program for the first time this past spring. This is a serious challenge for collecting data from the same participants across a five-year period of the longitudinal approach and for attempting to prove long-term impact of the project on participants.

In LA, the Family Science sessions were held at eight schools, and participants at one of the schools (Frank Del Olmo Elementary School) attended FS sessions at the Los Angeles Natural History Museum. Across all the LA sites, attendance fluctuated among the five sessions, with a total of 312 participants in the first session and 219 in the fifth and final session, a 30% drop in attendance.

The partnership with the Natural History Museum was a total success in integrating the two programs and getting families engaged throughout the five-week-course. Led by a museum scientist and two EasT students, with sustained support from the representative of the BAS project at the museum, this year's theme was focused on "turning dinosaurs into birds," addressing a range of biomechanics topics and engaging families in experiments and observations. It introduced families to the following five scientific topics.

- Connection between dinosaurs and birds, with a special focus on hollow bones, straw demonstration and experiment, feathers, and heat regulation
- Forces of flight: roll, pitch, yaw, drag, and lift
- Body design of birds: wing aspect ratio
- Micro-raptor flight: control
- "Becoming birds" experiment

The sessions at the museum were held on Saturdays from …. The first session was organized at one of the schools and the four remaining sessions were at the museum. Attendance was consistent (27–34 participants per sessions) and approximately half of the participants stayed after the FS session each week to experience the museum.

The partnership between staff at the museum and Iridescent has improved dramatically for several reasons, including more involvement of museum staff in informing the content of FS sessions, holding planning meetings with museum staff, deciding to use EasT alumni as instructors, and using MetroCards for family transportation (museum-paid transportation) instead of relying on private buses to pick up families at specific locations. In consultation with Iridescent, the museum plans to invite another BAS school to participate next year.

In New York City, families from two schools participated in the program. All five of the sessions were held at the New York Hall of Science (NYSci). Attendance held steady around 39 participants, with only a small drop on the last day to 36. The Family Science sessions in NYC started April 6 and ended May 4 and were held at NYSci. "This year's course focuses on biomimetics and this first week's session has our students imitating the gecko's system for always landing on its feet (which involves spinning its tail around in a clever way as it falls)."

Parents

Of the 197 parents who participated in the program, 67% were female and 33% male (see Appendix). Forty-six percent of parents completed the survey: 82% female and 18% male. The survey's response rate is high (46%) and does not include NYC parents. Parents from all the participating schools in LA responded to the survey, but the majority of respondents came from three schools: Western Avenue (34%), Norwood (18%), and Quincy (14%).

Close to half of the parents (48%) had attended Family Science before the 2013 spring program. Most of them (30%) participated in Family Science held in spring 2011.

The respondents who participated in the surveys had similar background characteristics across school sites. The majority of them were parents (90%), and most often that parent was a female (82%). Three-quarters of the families spoke Spanish at home (77%).

Understand the Goals of Family Science. Most of the parents enjoyed participating in the Family Science course and believed that the program had a positive impact on their STEM perceptions, attitudes, and knowledge. Other parents wrote that the goal was to inspire children to actually explore scientific concepts, build their confidence in perceiving themselves as scientist and engineers, and pursue careers in engineering or science. Some parents saw the goals of the project as an opportunity for them to improve their science content knowledge and to learn new ways to support their children's science learning. The sample quotes below illustrate some of the ways they articulated the program goals.

> "[The goals of the project are] for students to get some form of knowledge in the science department, get them to think, built, and built confidence. Hoping for them to pursue a career in science and technology."

> "[The goals of the projects are] to introduce and motive kids in different areas of science, to learn and to question. To spark interest in pursuing a career in engineering or science-related field."

> "The objective is that children become more interested in science, technology, engineering and math."

> "[The goals of the project are to assist] … children learn to do projects using their ingenuity and intelligence and abilities they did not think they had."

Have Positive Attitudes Toward Education. Most parents are very involved in their children's education. They indicated that they never miss a parent teacher conference (89%), are involved in their child's school (73%), and attend PTA meetings (50%). Nearly all parents (88%) agreed that their child would go to college.

Develop Positive STEM Attitudes. Parents' attitudes toward STEM are very positive (see Boxes 1 and 2, below). They have strong preferences about visiting informal science institutions (90%), watching science TV programs (87%), discussing science topics with friends and family (83%), and reading books with scientific themes (81%). Although half of them agreed that they often talk about science (50%) and watch science shows (51%), most of them did not go to informal institutions (80%) or read science books (63%) on a regular basis.

Acquire Positive Perceptions of STEM Jobs/Careers. Most participants perceived STEM jobs and careers as interesting (68%) and social (52%). As a result of participating in the BAS project, they agreed that they have better understanding of science/engineering and science/engineering jobs (82%), are more interested in science and engineering (80%), do more hands-on activities with their children (90%), watch more science-related TV shows with their children (91%), and read more science books with their children (90%).

Box 1: An LA Parent's Note to Iridescent Staff

I want to thank you for making my Mondays my favorite day. My son and I got to work as a team building rockets and cars.

The joy my son felt once we completed the project is something I will never forget. His eyes would light up and he would jump up and down to test drive them. I hope [my son] can carry this experience with him and learned that there is no greater than creating his own toys.

Box 2: A New York City Parent's Note to Iridescent Staff

I love Iridescent Learning. I have worked in non-profits all of my life and believe me when I say I meet so few who have this amount of inspiration in their core. Before I registered my family into their program, I had no idea that afterschool science education could be so meaningful and affordable.

So it's not just offering great science education to kids in low-income neighborhoods. No, it's that PLUS the powers that be get to figure out exactly what happens when you do such great things for kids? I am encouraged and inspired!

My son is definitely **not forgetting that he is a science lover**. He identifies himself as a scientist and is so proud of that. Despite any mistakes he may have made in class, he always walks away having explored and discovered new things about science and about himself.

Plan to Adopt Better STEM Child-Rearing Practices. Family Science has improved most parents' STEM child-rearing practices. Most parents plan to do more hands-on activities and watch more science-related TV shows with their children (91%) and read more science books with their children, ask their children more questions about their science classes, and take them to more informal science institutions (90%).

They are more confident talking about science and engineering topics with others, are more interested in science/engineering, and plan to encourage their children to pursue an education or career in science or engineering (80%). They believe that their children could someday have a career in science or engineering (73%).

Children

Of the 275 children who participated in the program, 60% were female and 40% male (see Appendix). Forty-nine percent of children responded to the survey: 57% female and 43% male. The age range of the students was between 4 and 15 years old. The majority of the children were between 7 and 9 years old (57%).

Although children who participated in the survey study came from all eight LA schools, most of them attended four of the eight schools: Western Avenue (21%), Quincy (21%), Betty (15%), and Norwood (14%). The children were of various ages (4–15 years old) and grade levels (PK–9); 43% were male and 57% female. Most of them said that their mothers frequently accompanied them to the sessions (38%). More than half of them indicated that they had attended Family Science courses before (59%): 38% in spring 2011 and 14% in spring 2012.

Most of the children have positive attitudes toward STEM activities, including building things (87%), visiting informal science institutions (85%), believing that they can be a good scientist or engineer (77%), exploring things to learn more about them (75%), and studying science in schools (74%).

As a result of participating in the BAS project, they agreed that they have become persistent in solving a design challenge (89%), are more excited about doing challenging STEM activities (88%), understand science and engineering better (83%), and are more interested in science at school (82%). One of the children said, "I had a lot of fun learning about science. I loved making a rocket and a car."

Overall the children seem to be doing well academically in school but performing below average in science. Parents reported that, on average, their children received mostly 4's and 3's (69%) on their academic scores and that, on average, their scores in science were either 1 or 2 (82%).

When asked to draw a picture of their favorite building or construction activity, 91% of students drew an accompanying picture. The drawings addressed three broad types of building and construction activities:

1. Showing built environment, including technology tools (53%)
2. Conducting science experiments, including seeing self in the experimentation process (31%)
3. Describing self in action making artifacts (17%)

Most of them explained in writing the content of their drawings (91%). The majority of these descriptions fell into the following making, building, and experimenting categories: Building homes and skyscrapers; creating technology tools; making transportation vehicles/devices; conducting science experiments focused on force and gravity; and experimenting with technology tools. The sample quotes below illustrate their building/construction experiences.

> "A crane is picking up something."
>
> "This is Downtown LA with the buildings and cars."
>
> "I drew the Washington monument."
>
> "I built a ramp that can launch a marble and hit the marble."
>
> "I was making a periscope."
>
> "I build a car using force."
>
> "In my picture there are materials to build a French horn. When I put everything together I make a French horn."
>
> "In this picture it shows that a hanger connected to a boy paper with weights hanging from it. It makes the box go down fast with the weight that it holds."
>
> "In my picture we were doing effort, fulcrum, load or lode."

When asked to imagine and draw a picture of an engineer at work, 85% of students responded to the challenge. The drawings depicted a range of rich engineering activities, including fixing and manipulating machines (e.g., cars, cranes, planes), space-flying, building construction, making airplanes and robots, drawing blueprints, and studying the natural environment. Eighty-five percent of the students offered descriptions of what the engineers are doing in their pictures. Sixty-four percent of these descriptions were related to the question asked and focused on engineering careers such as civil engineering (36%), mechanical engineering (32%), and aerospace engineering (16%). Some of the engineering careers included in small percentages related to jobs like construction workers, crane operators, bricklayers, electrical workers, and car mechanics.

> "The engineer is looking at his maps to see if the building is correct."
>
> "The engineer is sketching a building that he is about to build."
>
> "The engineer is building a speaker and a microphone."
>
> "He is going to make new home for homeless people."
>
> "The engineer is building a space shuttle going to space."

Dissemination

The USC Film Department partners are still producing videos for the project's dissemination and recruitment efforts. The team has completed four videos for dissemination and has additional raw footage about participating families. The first three videos were primarily intended for family recruitment and orientation. This year they shot and produced a video focused on the USC EasT student instructors for recruitment purposes.

One graduate student from the USC Film Department, who has participated in the project for the last three years as a filmmaker, has been a great asset for the project. He graduated in spring 2013 and expressed interest in continuing to work for the project as a consultant. As a result of participating in the project, he said that he benefited in the following ways: Gained more hands-on experience filming informal instructional settings, increased his understanding of the role of USC in the local community, and improved his confidence working with children.

Iridescent launched a multi-front dissemination effort in the past year. Through Iridescent infrastructure, the BAS project has made resources available to communities of interest by

- Creating online Family Science course lesson plans
- Presenting at conferences of the American Society of Engineering Education and the National Association for Research in Science Training
- Providing regular updates through the BAS website and Engineers as Teachers Facebook account

Finally, Iridescent is working with various higher education institutions (e.g., Ohio State University) and technology corporations (e.g., Boeing) to replicate the program and refine the model with museum partners (e.g., Lawrence Hall of Science). In these new iterations of the program, partners are invited to draw on Iridescent's rapidly growing online STEM resources and technology solutions for engaging in STEM activities with professional mentors and for sharing curricula and student's work.

CONCLUSION and RECOMMENDATIONS

Iridescent is on the right track to developing cost-effective ways to sustain and scale the STEM instructional qualities of the BAS project using efficient support strategies and relying on technology to expand the reach of Family Science and provide access to STEM human capital (e.g., mentors), creating science and engineering inquiry resources for parents. It continues to refine and strengthen key components of the project: EasT, FS nights, and museum partnership. Iridescent is deploying a more stable EasT training model focused on engineering education with various levels of design challenges. The pilot leadership program was a success, and remains a viable strategy for long-term sustainability. During the spring 2013 session, Iridescent staff and its partners successfully completed the recruitment of underserved families, training of undergraduate engineering students, implementation of the Family Science sessions at seven schools and two museums, and dissemination of their work within the field.

As a result of these efforts, EasT students, parents, and children benefited from the project. EasT students improved their communication and collaboration skills, gained better understanding of engineering concepts and design skills, and learned how to work with diverse audiences, including young children. Parents enjoyed the sessions, acquired scientific vocabulary, learned key scientific principles (e.g., *force*, *angular momentum*, *pressure*, and *ornithology*), improved their perceptions of STEM for themselves and their children, and increased their self-confidence about learning STEM. They plan to engage in more STEM activities with their children and encourage them to pursue science and engineering education.

With the support of EasT students, their parents, and Iridescent staff, the children expressed interest in STEM hands-on activities, made engineering design artifacts, inquired about how things are made from an engineering perspective, and learned about specific STEM design skills and content areas (e.g., gravity, force, pressure, and electricity). They have become persistent problem-solvers of design challenges and are starting to develop positive self-perceptions about STEM and an appreciation of civil engineering and technology and science experiments. Children are starting to understand the various types of activities that engineers do as jobs.

Challenges

Although the number of challenges that faced the program in previous years has decreased dramatically, Iridescent is confronted with some challenges in the areas of program management, the EasT course, and partnerships.

Program Management. The organization has had multiple staff turnovers and rapid business growth in the last four years. This situation has generated a range of management issues, including

- Lack of programmatic stability
- Staff burn-out
- Difficulties transferring institutional knowledge to new staff
- Confusion about roles and responsibilities

In addition, Iridescent staff have had technical difficulties with the keytag system. Some of the challenges included dealing with a high number of new registrants, lost keytag cards, lack of access to the system to record attendance, and lack of functionality of the database for queries associated with the keytag system.

Engineers as Teachers Course. The EasT component of the program continues to encounter challenges with recruitment, time and design challenges, and time and classroom management.

- Had difficulties recruiting sufficient numbers of undergraduate students in New York City
- Put more emphasis on the recruitment of undergraduate engineers who are better disposed to work with underserved families in LA
- Spent too much time trying to come up with engineering design challenges and had difficulties developing creative and age-appropriate engineering design challenges every week
- Struggled with classroom and time management during FS nights

- Did not emphasize enough that the FS course is for both parents and children

Partners. Although Iridescent is building partnerships as a strategy to sustain and scale the BAS, it has yet to fully capitalize on its existing partnerships with the USC Graduate Computer Engineering program, USC Film Department, Cooper Union, and NYSci. Some of the key challenges are

- Lack of alignment between the project's objectives and partners' deliverables at the USC Computer Engineering and USC Film departments
- Lack of monitoring of partners' activities, and not providing timely feedback on deliverables

Recommendations

To address these challenges in the complex context of the BAS project, CCT researchers recommend that Iridescent and partners consider the suggestions below.

- Try to home in on a set of critical program components, clarify staff's roles and responsibilities, empower staff to make decisions that contribute to achieving the project goals, and hold them accountable for their decisions.
- Address the technical difficulties with the keytag system to facilitate registration and data analysis. It is crucial to have a back-up system (such as a paper and pencil registration system) for recording attendance when the keytag system is not working.
- Reinstate family orientation at all participating sites, including the museums. Continue to offer an introductory session at the beginning of the program to help parents better understand program goals, participation expectations, and so on. This is also an opportune moment to help new parents set up their email and register for their keytags.
- Recruit teachers at participating schools to assist parent leaders in their tasks.
- Improve coordination of FS activities across sites (both NYC and LA), including the EasT program.
- Increase the number of FS nights at school sites.

- Provide EasT students access to past lesson plans and experiments to stimulate their creativity and reduce the time spent trying to come up with engineering design challenges.
- Engage EasT students in more brainstorming activities.
- Start FS nights early in the semester to allow EasT students to practice their instructional skills.
- Alternate presentations and themes to make the EasT course more interesting for the undergraduate students.
- Have more Iridescent staff participate during the EasT students' presentations at USC to provide feedback and guidance.

- Do a better job of engaging parents in the FS activities.

- Use the new model of partnership between the Natural History Museum and Iridescent to inform Iridescent's work with NYSci.
- Work in collaboration with the USC Film Department to develop a relevant and coherent set of activities for 2014 and 2015, including clear specifications, timelines, and deliverables.
- Work in collaboration with the USC graduate computer engineers and their adviser to re-align the objectives of their scope of work and deliverables for 2014 and 2015, including clear specifications, timelines, and deliverables.
- Encourage the project's Co-PIs to review their roles as set out in the original proposal in order to clarify leadership's parameters and expectations.
- Empower co-PIs to have meetings to address challenges, make decisions, or clarify implementation.

Next Steps: Evaluation

CCT researchers will finalize the formative evaluation and start the summative evaluation in 2014. The last year of the project will be committed entirely to collecting and analyzing the summative data.

Year 4 Formative Evaluation Plan. CCT researchers will conduct site visits, administer surveys, and collect relevant documents. The data will be analyzed to identify the strengths and weaknesses of program components for replicability and sustainability, to provide recommendations for program improvements, and to assess program impact on participants.

Year 4 Summative Evaluation Plan. To prepare for the full evaluation in Year Five, CCT researchers will work closely with Iridescent staff to identify families' various levels of involvement with the BAS project in the last four years. The purpose of this categorization is to better understand how the project affected families with different levels of participation. For example, we assume that we will learn more about program impact from families who have consistently participated in the program for the last four years.

Year 5 Summative Evaluation Plan. CCT researchers will conduct a summative evaluation in 2015. The evaluation will focus on how well the project met its goals of creating a sustainable and scalable model of family science in underserved communities and improving families' understanding of science and engineering. CCT researchers will measure the degree of involvement of families in the BAS project and the impact of the project on participants. This summative phase will culminate in the delivery of a final research report.

APPENDIX

List of Items:

1. Parent Data Spring 2013
2. Student Data Spring 2013
3. EasT Student Data Spring 2013
4. Parent Survey
5. Student Survey
6. Engineers as Teachers Interview
7. Student Interview
8. Parent Interview
9. List of Partners
10. Parent Leaders as a Sustainable Strategy
11. EasT Training and Family Science Courses in New York City
12. EasT Training and Family Science Courses in Los Angeles

Parent Data Spring 2013

School	Number of Participants	Gender		Relation	
		Female	Male	Parent	Other
32nd Street	15	12	3	15	0
Frank del Olmo	17	11	6	17	0
Norwood	19	16	3	19	0
Plasencia	28	19	9	27	1
Quincy Jones	27	18	9	27	0
Synergy	21	17	4	21	0
Vermont	20	16	4	18	2
Western	21	17	4	21	
NY Hall of Science	29	17	12	24	5
Total across school sites	197	143	54	189	8

Children Data Spring 2013

School	Number of Participants	Gender	
		Female	Male
32nd Street	21	12	9
Frank del Olmo	24	12	12
Norwood	45	25	20
Plasencia	34	16	18
Quincy Jones	44	26	18
Synergy	33	20	13
Vermont	22	17	7
Western	31	19	12
NY Hall of Science	21	13	8
Total across school sites	275	160	117

EAST Students Data Spring 2013

School	Institutions	Number of Participants	Gender	
			Female	Male
Los Angeles	1	28	7	21
New York City	3	1	-	1
Total across sites	4	29	7	22

Parent Survey (Spring 2012)

1) Full name of your child's school: ____

2) Relationship to child: __ Parent ____Other (specify): ______________________________

3) Are you: __ Male __Female

4) What is the primary language spoken in your home?

__English
__Spanish
__American Sign Language
__Other (specify):______________________

5) How did you hear about this program? (Select all that apply)

__ Participation in another Iridescent program
__ Child's school
__ Teacher
__ The internet, email
__ A flyer
__ A friend
__ Walk by the Iridescent studio
__ Science Festival
__ Iridescent staff member
__ Child mentioned it to me

6) Have you attended Family Science before? _______ Yes ________ No

7) If yes, when? ________Spring 2011 _______Fall 2011

8) What do you understand are the goals of the Iridescent Family Science program?

____
____
____
____

9) Please make an **X** on the continuum closest to the word that describes how you feel about science, math, engineering and technology jobs/careers?

Science, math, engineering and technology jobs/careers are…

a) ____|_________|___________________|___________________|_______________|_____
Hard to find Easy to find

b)
_____|__________________|______________|___________________|__________________|____
Not interesting Very interesting

c) _____|_____________|___________________|___________________|________________|____
Not social Very social

d) _____|____________|___________________|___________________|_________________|____
Very complicated Very easy

e) _____|_____________|___________________|________________|__________________|____
Not secure/not stable Very secure/stable

10) Please read and mark an **X** in the box of the choice that most truthfully tells how you feel about that statement.

Statements	**Strongly disagree**	**Disagree**	**Not sure**	**Agree**	**Strongly agree**
I like to watch television programs about science.					
I like to visit zoos, science museums, nature centers, science fairs, etc.					
I like to talk about science topics with friends and family.					
I like to read books with scientific themes.					
I never miss a parent teacher conference.					
I check my child's grades online.					
I regularly attend PTA meetings.					
I am involved in my child's school.					

11) Please read and mark an **X** in the box of the choice that most truthfully tells how often you do the following activities with your child/children?

Activities	**Never**	**A few times a year**	**At least once a month**	**At least once a week**	**Daily**
Read science books					
Talk about science					
Watch science shows					
Go to zoos, science museums, nature centers, science fairs, etc.					

12) On your child's last report card, what grades did s/he mostly get? (Please check only one.)

____ Mostly 4's ____ Mostly 3's ____ Mostly 2's ____ Mostly 1's ____ Mostly 0's

13) On your child's last report card, what grade did s/he get in **science**? (Please check only one.)

____ 4 ____ 3 ____ 2 ____ 1 ____ 0

14) I think my child will go to college. _____Yes ______ No ______ Not Sure

15) Please read and mark an **X** in the box of the choice that most truthfully tells how you feel about that statement.

After participating in this program, …	**Strongly disagree**	**Disagree**	**Not sure**	**Agre e**	**Strongly agree**
I understand science/engineering better.					
I am more interested in science/engineering.					
I have a better understanding of the jobs in science and engineering.					
I believe that my child could someday have a career in science or engineering.					
I will do more hands on activities with my child(ren).					
I will ask my child(ren) more questions about his or her science class.					
I will take my child(ren) to more zoos, science museums, nature centers, science fairs, etc.					
I will watch more science related TV shows with my child(ren).					
I will read more science books with my child(ren).					
I will encourage my child(ren) to pursue an education or career in science or engineering.					
I am more confident talking about science/engineering topics with others.					

Thank you for completing this survey!

Student Survey (Spring 2012)

1) Your full name: ____

2) Your school name: ____

3) How old are you? _____ years

4) What grade are you in? _____________

5) Are you a: __ Boy __ Girl

6) Who brought you to Family Science today? Please list their name and relationship to you.

____

____

7a) Have you attended Family Science before? _______ Yes _______ No

7b) If yes, when? ________Spring 2011 _______Fall 2011

7c) If yes, who brought you to Family Science most frequently?

____

6a) Please draw a picture of your favorite building/construction activity in the box below.

6b) Tell us what is happening in your picture.

____

____

____

7a) Close your eyes and imagine an engineer at work. In the space below, draw what you imagined.

7a) Describe what the engineer is doing in this picture.

____

____

8) Please read the following to the students and ask them to circle the choice that most truthfully tells how they feel about that statement. Tell them there are no right or wrong answers; we just want their opinion.

Statements	**agree** … **disagree**
I like to watch television programs or movies about science.	
I like studying science in school.	
I like to visit zoos, museums, nature centers and parks to observe things.	
I like to ask a lot of questions in school.	
I like to touch different things to learn more about them.	
I like to build things.	
I think I would be a good scientist or engineer.	

After participating in this program, …	agree disagree
I understand science and engineering better.	
I am more interested in science at school.	
I have a better understanding of the jobs in science and engineering.	
I am more likely to keep trying if I don't figure something out after the first attempt.	
I do more science related activities with my family.	
I ask more questions about what is happening in the world around me.	
I am more excited about doing challenging activities.	

Engineers as Teachers Interview

Experience

1. Tell us generally about the class and the coursework.
2. How would you describe your experience in the class?
3. Why did you decide to take this class?

Successes

1. What worked well in this class?
2. What did you learn in this class?
3. What did you find most rewarding about the class?
4. What was your biggest success while teaching the Family Science course?
5. Would you recommend this class to a peer? Explain your answer.

Challenges

1. What was challenging about this class?
2. What do you wish the teacher had done differently?
3. What do you wish YOU had done differently?
4. What was challenging about being in the field and teaching?

5. What recommendations would you make to the teacher to help improve the class for next semester?

In closing, is there anything you would like to talk about that we did not ask?

Thank you for the information!

Student Interview

Introduction

Number of participants: _________________

Boys: _____________ Girls: ______________

Age of students: ____

Student grade levels: ____

Background/Experience

1. How many times have you come to family science before? _______________________
2. Why did you decide to participate in Family Science?
3. Who did you come with tonight? Who from your family usually comes with you?
4. In general, what do you like most about the Family Science program?

Impact

1. How does your science experience here at Family Science compare with your science experience at school?
2. Since coming to Family Science do you like learning about science more, less or the same?
3. What can you do now that you couldn't do before?
4. Do you do these kinds of projects at home? If yes, who do you do them with?
5. What do you want to be when you grow up?

Challenges

1. What is hard/challenging about coming to the Family Science class?
2. Is there anything you wish you could have done in Family Science but didn't do?

In closing, is there anything you would like to talk about that we did not ask?

Thank you for the information!

Parent Interview

Introduction

Number of participants: __________________

Male: __________ Female: ____________

Background/Experience

1. How many times have you come to family science before? ________________________
2. Why did you decide to participate in Family Science?
3. Who did you come with tonight? Who from your family usually comes with you?
4. In general, how has your experience been at Family Science?

Impact

1. What do you enjoy most about coming to Family Science?
2. How has participating in the program impacted your children? What changes, if any do you see in him/her/them?
3. Do you find that you are doing more hands-on projects at home since you started coming to the program? If yes, please describe the projects.
4. Since you started coming to Family Science do you find that you are doing more activities with your child(ren)? (Probe: reading more science books, watching more science related TV shows, going to more zoo, science museums, or nature centers, etc.)
5. Are you spending more time doing other activities with your children? If yes, what are those activities?

Challenges

1. What has been most challenging about participating in the program?
2. Do you wish the program were different in any way? If yes, how so?
3. Would you recommend this program to your friends? If yes, why?

In closing, is there anything you would like to talk about that we did not ask?

Thank you for the information!

List of Partners

Schools:

1. 32nd Street School, Los Angeles, CA
2. Betty Plasencia Elementary School, Los Angeles, CA
3. Frank Del Olmo Elementary School, Los Angeles, CA
4. Norwood St. School, Los Angeles, CA
5. Quincy Jones Elementary School, Los Angeles, CA
6. Synergy Academy, Los Angeles, CA
7. Vermont Avenue Elementary School, Los Angeles, CA
8. Western Avenue Elementary School, Los Angeles, CA

Museums:

1. Natural History Museum (NHM) of Los Angeles, Los Angeles, CA
2. New York Hall of Science (NYSci), New York, NY

Universities:

1. Cooper Union: Electrical engineering department
2. University of Southern California: Integrated Media Systems Center, School of Cinematic Arts department, and aerospace and mechanical/electrical engineering department

Parent Leaders As A Sustainable Strategy

Iridescent continues to create a sustainable parent co-investment model and is dealing with how to maintain program quality in this context. This year they have invested in a pilot parent leadership program in LA. Iridescent hired a manager to run this new Family Science program component, which is designed to empower parents at the local community level to take on leadership roles in the day-to-day management of the BAS project (e.g., site set-up, food, scheduling, facilitation) and help sustain the project and make/render it scalable, support recruitment and retention of families (e.g., making reminder phone calls to families, collecting data about drop out families), which was a heavy burden resource wise for Iridescent.

Iridescent staff introduced a selected number of six parents from three of the eight BAS schools to its leadership development strategies, family science implementation logistics, and family science inquiry approach. One parent at each school was chosen as the school liaison. The three two-hour-training sessions assisted parent-leaders in understanding their own leadership style, building their confidence to manage a family science course, and facilitating science inquiry practices during a family science course. Specifically, parents had the opportunity to reflect on their leadership and collaboration styles and learn how to develop community agreements for the family science workshops. They received logistics training via a parent toolkit for organizing family science courses, including creating committees, timelines, and scripts. In addition, they were taught how to ask better questions and assist children in developing problem solving and critical thinking skills, pay attention to different learning styles, and build science artifacts with young children.

Iridescent is in the process of formalizing its parent leadership program with its partners. It established a memorandum of understanding with three of the schools in LA to help them run the parent leader program and provided a clear outline of responsibility among its staff, school partners, and parent leaders (see Table 4). Iridescent is in the process of finalizing a *Family Science Manual: A Guide for Parent Leaders* (2013). The goal of the training manual is to share best practices with schools and communities interested in hosting family science in the future. The draft provides guidance about how to start a family science program, plan a family science course, develop recruitment strategies and tools, manage the implementation process and volunteers, and evaluate a session. The document target audience is comprised of educators, parent leaders, scientists, and engineers.

Table 4: Division of Responsibilities

Program Component	Iridescent	School Partners	Parent Leaders (PL)
Staff/PL recruitment	Provide engineer instructors to teach FSN.	Identify 3-5 parents for the Parent Leader Program. Assign a point person as the school liaison.	Commit to supporting FSN at each partner school.
FSN Training	Train PL to run Family Science Nights.	Host EasT students for demos with parents or students.	Attend FSN trainings.
FSN Logistics	Support PL and schools with FSN logistics.	Support PL with FSN logistics.	PL will lead Family Science Night logistics.
Collection of Data	Track attendance data for retention and recruitment.	Support data collection efforts.	Assist in the check process to collect attendance data.
Collaboration	Run monthly partner meetings and PL reflection meetings.	Attend monthly partner meetings.	Attend FSN reflection meetings during 5-week session.
Evaluation	Provide workshop surveys, PL reflection meetings and support, data reports to schools.	Give feedback and input at monthly partner meetings to help set program improvement goals.	Give feedback and input at FSN reflection meetings to help set program improvement goals.

EasT Training and Family Science Courses in New York City

Overall, the training went well despite the low number of participants. The one participating student is pursuing a civil engineering degree and was provided a stipend for participation. The training sessions of the EasT student in New York City were held at the Iridescent Studio in the South Bronx from February 28 to March 28, 2013. The first training class focused on jargon-free exercises. The EasT student worked with Iridescent staff to develop the curriculum, including materials, demos, and designs, and prepared his computer slides for his lessons. He picked up the materials from the studio and dropped them at NYSci the day before each FS session, set up the class (e.g., projector, light, materials), and brought in the food.

The EasT student felt more comfortable teaching Family Science courses as he learned about how to make authentic design through watching videos about how parents can better support their children in learning about engineering; reviewed research papers; created lesson plans; prototyped the lesson plans with families at the Iridescent studio in the South Bronx; addressed the feedback he received from his mentor; and taught five Family Science courses at NYSci. He improved his communication skills, gained deeper STEM knowledge, increased his cultural competence working with disadvantaged families, and became better at dealing with instructional issues during the FS courses. According to the EasT student, "Family Science rekindled my desire to teach STEM to people."

NYSci's role in the implementation of Family Science courses has been very limited this year. Although NYSci and Iridescent staff initially discussed how to collaborate in the spring, including NYSci providing the space for the implementation of the Family Science courses, they were unable to collaborate in shaping the content of the course and exploring connections between Family Science and the museum's exhibits. One NYSci staff member attended the first three FS sessions and assisted with logistics.

Two schools participated in the FS program. In one school where the parent coordinator is part of the Iridescent program, there was full student attendance. However, at the second school, where the parent coordinator was not responsive to Iridescent staff, student attendance was low. In addition, this non-responsive school is located too far from the museum.

Despite these challenges, Iridescent staff successfully completed five FS courses and worked with 29 parents and 21 students. There was a high retention rate. While the keytag system worked well, Iridescent staff still need more support in ensuring that every participant signs in.

The FS science courses at NYSci were held from 9:00 AM to 11:00 AM. Iridescent provided breakfast to 15 families. The courses were typically organized around the following activities:

- Creating mini-designs and sharing design observations
- Accessing participants' prior knowledge via Q&As, and linking mini-designs to the instructor's lecture by creating relevant links between design and engineering concepts
- Providing visuals of animals for real-life connections
- Drawing and designing using learning tools, and designing, testing, and redesigning their artifacts
- Sharing all their designs

During the sessions, the instructor covered the topics of efficient communication, gecko biomimicry, basilisk lizard tail biomimetics, elephant trunk biomimetics, biomimicry of flight, and jellyfish biomimetics. The lessons were effectively delivered throughout the sessions.

The instructor observed that there were four common types of child-parent interactions during the courses:

- Child is not interested in designing/building but parent helps child.
- Child is interested in designing/building and parent still takes over and controls the process.
- Child is interested in designing/building and is doing it independently.
- Parent is interested in designing/building and is doing it independently.

Participants tested their designs. However, it was a challenge for them to engage in the redesign process of their designs, in part because of the lack of time and interest and lack of patience to deal with design challenges. This latter challenge might be age-related (e.g., too young socially and mentally to handle challenging design problems).

The Family Science program has had a positive impact on staff and participants. The project manager believes that they were successful in making a much better connection between the environment in which the families live and the topic of engineering, providing a more robust engineering and design FS course, doing fun and accessible activities with animals, training students to become better observers, learning new scientific vocabulary based on activities (Zero net force demonstrations) and engineering design steps, learning and acting out their observations, and doing more kinesthetic science. According to the Iridescent project manager, "Families are more engaged with the lecture. They are getting much more from the FS course."

Families had fun during the sessions. They acquired some scientific vocabulary and learned key STEM content knowledge, including *force*, *angular momentum*, *pressure*, *suction*, and *ornithology*. Parents realized that their children are very creative, and that they should let them explore their interests and support them in the pursuit of realizing their ideas. Participating children were exposed to the idea that science can be a fun subject.

> "Iridescent staff were able to get the parents to do things that they otherwise thought they couldn't do."

The children became more creative, understood better how to tinker, and learned how to use the design process. As a result, they were better able to handle their frustrations during the design, test, and redesign process.

> "Children [participating in the Family Science program] were very independent and encouraged to own their learning experiences and guide their own discoveries."

As this was the last session at this site, Iridescent staff thanked BAS families for their participation in the project and shared pictures from each of the sessions. In addition, they shared the link to Iridescent's Curiosity Machine website (www.curiositymachine.org) and encouraged them to continue to explore STEM topics at home using the site.

Challenges

EasT Program Management

- Lack of connection between the EasT and FS curriculum and NYSci's education offerings.
- Lack of NYSci's input and feedback during the development of EasT and FS curriculum.
- Lack of co-planning of BAS activities between NYSci and Iridescent staff.
- Lack of coordination and sharing between Iridescent's and EasT coordinators.

EasT Partners

- Iridescent staff had difficulties collaborating with Cooper Union. Context at Cooper Union has had a negative impact on the working relationships between Iridescent and the BAS co-PI at Cooper Union. Faculty, students, and the institution's leadership spent a contentious year struggling over continuing to offer a free full-tuition scholarship or requiring a half-tuition scholarship.

EasT Students

- Their initial perceptions and expectations of the EasT course and Family Science nights were low. Most undergraduate students gravitate toward the EasT course because of their perception that it is an easy course to take in a very rigorous engineering program, and thus follows the assumption of obtaining an easy high score in the course.
- Have difficulties managing their FS commitment, especially when they take a lot of courses and engage in a lot of extra-curricular activities.

Recommendations

- Increase the number of East sites/partners
- Better organize the EasT schedule
- Recruit more diverse people in the EasT program—local community (e.g., Spanish, Southeast Asian)
- Have Iridescent and NYSci staff provide timely feedback to EasT students
- Allow recruitment of EasT students before the class starts
- Get more volunteers connected with the partner institutions to help with recruitment and implementation of EasT training course
- Have the EasT program institutionalized in universities in New York City
- Have NYSci offer Maker Space as a place to prototype design activities and activity set-up
- Co-plan EasT training and FS sessions
- Co-review past FS curricula materials and determine how to complement them with NYSci's expertise and resources
- Organize a debriefing session with NYSci staffers
- Institute a collaboration between the two EasT coordinators

EasT Training and Family Science Courses in Los Angeles

A new Iridescent instructor, who is an engineer by training, ran the EasT program this year. With the support of a Teaching Assistant (TA, an EasT alumnus studying mechanical engineering), she focused the course squarely on engineering design education and advised students on design engineering, presentations, and logistics for FS nights in the community. The TA assisted her, providing presentation and instructional feedback to the EasT students and scheduling FS courses at each school site.

In addition, the instructor trained 19 high-school students in LA to support the implementation of FS at the school sites. The students assisted Iridescent staff and EasT instructors in preparing for the courses and helping families during the courses.

Fifty USC engineering students attend the informational session about the undergraduate course in fall 2012. However, Iridescent capped the registration at 30 students to ensure easy management and the delivery of quality instruction to the students. Most of the students heard about the program through word-of-mouth. The final number of EasT participants was 28 students: 7 female and 21 male. They were mostly paired in groups of three, and received course credit for their participation in the BAS project.

EasT Course at USC. The USC EasT class ran from January 15 to April 30, 2013. EasT students worked on coming up with creative engineering design challenges in ten weeks, honing their presentation and communication skills, and learning how to work with each other and with underserved families, including beconing familiar with the characteristics and processes of participating schools. Specifically, the instructor required the students to understand the nature of engineering design challenges (e.g., methods of science inquiries, how to create engineering design challenge formats and prototypes), helped them focus on how to implement multiple levels of engineering design challenges during one FS session, and shared with them various classroom management strategies (e.g., how to occupy families who finish their task early). As compared to past EasT courses, this year the focus was less about understanding various theories of pedagogy and cultural competencies and more about teaching engineering in informal settings.

EasT students were engaged and interested in participating in the course at USC. They improved their communication and presentation skills, increased their self-confidence in speaking in public and to diverse audiences, gained a better understanding in how to create successful engineering design challenges, enjoyed contributing to the local community, and sharpened their understanding of key engineering concepts. They learned how to create lesson plans. The EasT students indicated that they had fun going to the school sites and creating prototypes, and they plan to recommend the EasT undergraduate class to peers.

EasT Students at Family Science. The FS courses, which focused on various types of science inquiries, were offered once a week between April 1 and May 3, 2013, at seven of the eight schools. The LA EasT students taught the following topics:

- Medieval Engineering (Norwood)
- Engineering of Action Sports (Synergy)
- Build Big! (Betty Plascencia)
- Submarines—The Navy's Ninjas (Quincy Jones)
- The Life of Water (32nd Street)
- Constructing a Man-Made World (Western)
- Green Room: Engineering Musical Instruments (Vermont)

EasT students shared their presentation documents with their translators ahead of time. This was an efficient communication strategy.

Families' attendance and retention were consistent in LA.

At one FS session in LA (observed by CCT researchers), there were approximately 17 families (17 adults and 33 children), three EasT students, two Iridescent staff, three high-school students, and one school parent representative. One of the EasT students translated the presentation and assisted families who spoke only Spanish.

Families in the program had dinner from 5:00–5:30. Families filled out evaluation surveys as they ate their dinner. Some parents were on their cell phones. Children walked back and forth constantly, and there were a lot of commotions during this period. So, it took at least 10 minutes to clean up and transition to the lecture phase of the session.

The EasT students spent 20 minutes introducing the project, themselves, and the topic. Although they did a recap of the previous week's lesson, their presentation focused on the nature of electricity, circuitry, and conductivity. EasT students demonstrated a good use of pedagogical techniques, such as asking questions, acknowledging children's participation, and inviting the children to participate in a physical demonstration of conductivity.

After the lecture, the families were offered the list of materials they would need in order to participate in the engineering design challenge, and were shown a sample of a completed design challenge on the screen. The high school students handed the children the learning tools. The children filled them out and went to the materials station to show the learning tools and pick the materials to conduct their design experiments.

The children were very excited about working on their design challenges, often with the support of an adult. One of the children cried out, "I figured it out!" after 15 minutes of tinkering with the materials. Another child murmured that he was "trying to make a source of power." Toward the end of the session, children were eager to take home their completed design experiments. One child said to his mother in a very proud voice, "Come, we take it home to show it to Daddy!"

The EasT did a recap at the end of the session, invited the audience to ask questions, handed over certificates to the children, and took a group picture.

In addition, the EasT students facilitated the process of families filling out the learning tools.[1] Seven schools filled out the learning tool, which asks questions about curiosity regarding science, design, and engineering, and program impact. EasT students collected a total of 663 learning tools. Twenty-three percent of the tools were filled out completely (see Table 5) and focused on various engineering design challenges, including the building and understanding of the structure of bridges; musical instruments (e.g., drums, guitars) and sound engineering and technologies (e.g., microphones, speakers); submarines, propellers, periscopes, skyscrapers, slides, and aqueducts; and how the making of these tools requires the mastery of key science concepts, such as velocity, force, mass, gravity, density, and electricity.

[1] CCT researchers content-analyzed the completed learning tools.

Table 5: Learning Tools

	Number of tools	Completed
1. Synergy Charter Academy	83	6
2. Vermont Elementary	104	40
3. 32nd Street Elementary	39	32
4. Quincy Jones Elementary	109	48
5. Norwood Elementary	107	13
6. Betty Plasencia Elementary	105	0
7. Western Elementary	116	14
Total	**663**	**153**

Most participants who completed the learning tool asked relevant scientific questions. They demonstrated that they had developed deep scientific curiosity about the topics they were taught during Family Science. Participants commonly asked four types of scientific and design/engineering questions, which are defined and illustrated with quotes below.

- *Process*: How do things work or how are they made (e.g., a tool or a scientific phenomenon)?
    - *"How does electricity work?"*
    - *"How does a fulcrum work?"*
    - *How do I transfer water from the bottom to the top?"*
    - *How does air affect flight?"*
    - *"How does a drum make a sound?"*
    - *"How does sound travel through a microphone?"*
    - *"How do you make a waterproof house?"*
- *Material*: What are the materials needed to make or build specific artifacts, or what are the different components of tools?
    - *"What materials would be used to make a skyscraper?"*
    - *"What do I need to keep my arch from falling?"*
    - *"What are the most important parts of a speaker?"*
    - *"What materials are best for waterproofing a house?"*
- *Meaning of scientific concepts*: What is the definition of *mass*, *density*, *gravity*, etc.?
    - *"What is tension and compression?"*
    - *"What is density?"*
- *Cause and effect*: What are the causal relationships between variables?
    - *"What happen if a generator in a submarine stops working?"*
- *Purpose*: What are things used or made for?
    - *What is it [a periscope] used for?*

Most participants were able to plan their design challenges, test them and describe their results, and redesign their projects using lessons learned from the test phase. Most of their test results showed the limits of their designs, and they seemed to understand what was needed to improve them. The quotes below illustrate their observations after the test phase, and some of their eagerness to continue to tackle their design challenges.

> "It worked, but we needed a … cup for the crank can move."
> "It [design] kind of work."
> "I had to close some parts of the cups, but it worked properly."
> "The water become very warm and I knew that wasn't good."
> "My design needed an extra piece."
> "It made a sound, but it was a little low."
> "The bigger one [music instrument] made shorter sounds and smallest one made louder sounds."
> "It did not work, but I will do it the next time."

As a result of participating in these activities, participants indicated that they felt proud for learning about science in general and about specific science content knowledge (e.g., energy, balance, force), for learning how to build scientific tools (e.g., periscopes), structures (e.g., bridges, skyscrapers), submersible vehicles (e.g., submarines), and for learning research skills (e.g., conducting observations to test their ideas, using data to make design improvements, problem-solving). They demonstrated persistence throughout the entire process because of the level of engagement with hands-on activities.

> "I am proud for learning how to build a periscope."
> "I am proud for learning density is mass and weight."
> "I am proud for learning about skyscrapers, but also how to design them."
> "I am proud for building a scientific instrument."
> "I am proud for building force using a propeller."
> "I am proud because even though it didn't work, at least we tried our best."

Overall, the children were more involved when doing hands-on activities, and expressed interest in making engineering design artifacts. According to some EasT students, children asked a lot of questions about race cars, tires of race cars, and engineering education choices. As a result of participating in FS, the children learned about gravity, force, pressure, and electricity. They saw how these concepts are applied to specific designs. Some families took pictures of their children's projects and shared them with other family members.

Challenges

Improving Coordination of EasT Program

- Lack of coordination and sharing between Iridescent and EasT coordinators.
- The two Iridescent coordinators of the EasT undergraduate classes did not meet to share experiences and best practices during the spring 2013 session.
- EasT coordinator in LA plans to dedicate two classes to brainstorming activities next year.

Expanding the Program to Other Schools

- Iridescent staff in LA aimed to recruit more school sites but struggled with the logistics of planning EasT courses for 11 sites. Each school wanted different times for offering the FS courses to families.

Creating Engineering Design Challenges and Presentations

- Some of the EasT students had difficulties coming up with a creative, interesting, and age-appropriate (for both children and adults) engineering design challenge every week.

- Most of the students felt that the presentation rehearsals were a waste of time and could have been organized differently. Most of the students were not paying attention to the presentations and were engaged in other activities. There is a lack of classroom participation during students' presentations.

Improving Family Science

- EasT students struggled with time and classroom management (e.g., not being able to complete the course on time, not having time to send families home with specific instructions for the next class or to propose activities that the families can engage in at home). Time management was a major issue in the first couple of weeks of the FS sessions.
- EasT students did not emphasize enough that the FS course is for both parents and children, and have to do a better job of engaging parents in the activities.
- Delivery of instruction via lectures remains ineffective, and interruptions seem to increase during lectures.
- EasT students have to spend more time planning the delivery of their instruction and make more interactive demonstrations.
- Some of the EasT students had language barriers speaking with some of the parents and connecting with the younger children.

Recommendations

- Start FS early in the semester to allow EasT students to practice their instructional skills.
- Have more Iridescent staff participate to provide feedback and guidance during the EasT students' presentations at USC.
- Provide the students with access to past EasT lesson plans and experiments to stimulate their creativity and reduce the time spent trying to come up with engineering design challenges.
- Alternate presentations and themes during EasT courses.
- Meet regularly at each site and across sites.
- Increase the number of FS nights at each school.