

Summative Evaluation Report for the Be A Scientist! Project's Family Science Program



Submitted to Iridescent/Be A Scientist! Program

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September 2015

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Summative Evaluation Report for the Be A Scientist! Project's Family Science Program

Executive Summary

"What I like the most is I get to sit with my kids and work with them, which we hardly do at home. That's why it's called Family Science, because it's the family that gets together and builds stuff, stuff that you usually don't get to do at home. It is a time where you spend time with your kids and doing what they like."

—Mother of a 5th grade student

The Be A Scientist Family Science program brought families from under-resourced communities in Los Angeles and New York into communication with young science professionals in ways that allowed parents and children to engage with new ideas and materials and to learn about various STEM concepts. Participants engaged in STEM experiences that were hands-on, age-appropriate, content-rich, and guided by young and knowledgeable adults (engineering undergraduate students), who modeled ways of engaging informally with science while still targeting key concepts. These experiences took place in school settings—environments where parents are rarely involved in their children's learning—and were open to entire families, including younger and older siblings and extended family members. All of these aspects combined to create a strong and lasting impact on the children, families, and engineering students involved.

Over the five-year initiative, Be A Scientist Family Science program achieved the three goals identified in the program's initial proposal:

- engaging underserved families living in low-income communities;
- increasing parent involvement in student learning; and
- providing social capital by way of access to engineering students.

The Family Science program also had impacts on additional dimensions that were not directly targeted by the organization, including fostering scientific thinking skills among students and parents, inspiring children toward STEM careers, increasing the number of STEM-related activities students and parents engage in at home, and improving engineers' communication skills. Previous evaluation reports reveal similar impacts, which highlight Iridescent's quality program implementation over the five years, despite changes in staff and partners, and tweaks to the program offerings.

Key Findings for the 2015 Program Year

Impacts on students

Students participating in the 2015 Family Science after-school program were interested in and engaged with science- and engineering-related activities, both in and outside of school.

Students indicated that participating in the Family Science program had positive impacts on their knowledge, attitudes, and behaviors. The vast majority of students indicated that they understand science and engineering better (90%), and that they had a better understanding of what jobs are available in those fields (88%). Students also responded that they were more excited about doing challenging activities (94%), and that they are more interested in their science class at school (86%). They reported being more engaged in practices of scientific thinking, such as persistence (89%) and questioning (79%).

Impacts on parents and family members

The parents and family members of the children who participated in the Family Science program reported being highly engaged at their children's schools. Overwhelmingly, they also report positive changes in their own behavior since participating in the Family Science program. Over 93% of all respondents agreed or strongly agreed that, since participating in the program, they would engage in more science-related activities such as visiting zoos, reading books about science, watching science-related TV shows, and doing hands-on science activities at home. Similarly, 94% indicated that they would ask their child more questions about science class, and 91% said they would encourage their child to pursue an education or career in science or engineering. Ninety-two percent of respondents indicated that they understand science and engineering better, and 89% said they are more interested in those content areas.

Impacts on Engineers as Teachers (EasT) participants

An overwhelming majority of the undergraduate engineering students reported having a positive experience in the EasT course. They enjoyed working together, co-facilitating the workshops, and engaging in meaningful interactions with students and families. Most of the 2015 engineers (80%) reported that, since participating in the EasT course, they feel more comfortable managing a classroom of students and that they feel more proficient working with children. Three-quarters of the students (75%) reported improved communication skills, specifically public speaking and communicating complex science ideas to non-scientific audiences.

Program Evaluation

Beginning in autumn 2011, Education Development Center's Center for Children and Technology (EDC|CCT) worked closely with Iridescent to evaluate the impact of its Family Science after-school program on its participants and partners. Between September 2011 and April 2015, Iridescent held six series of five-week programs in New York and Los Angeles at nine different school and museum sites. Iridescent worked with the same eight schools and two museum partners over the five years, and served 2,173 participants, including children and families, for 18,628 hours over the five years. This summative report provides findings from the spring 2015 Family Science sessions (the final year of the program), and describes summative impacts that have accrued over the past five years.

Summative Evaluation Report for the Be A Scientist! Project's Family Science Program

Introduction

Beginning in autumn 2011, Education Development Center's Center for Children and Technology (EDC|CCT) worked closely with Iridescent to evaluate the impact of its Family Science after-school program on its participants and partners.¹ Between September 2011 and April 2015, Iridescent held six series of five-week programs in New York and Los Angeles at nine different school and museum sites. The program activities centered on "design challenges" that introduced families to the engineering design process and supported the development of curiosity, creativity, and persistence. These five-week programs consisted of five unique sessions and were held seasonally, including spring 2011, fall 2011, spring 2012, spring 2013, spring 2014, and spring 2015, for a total of 259 sessions overall. The school-based programs took place in early evening during dinnertime (with pizza and refreshments provided to all attendees) to make it easier for whole families to attend the program together. Sessions held at the museum partner sites took place on Saturday mornings to allow families to enjoy the museums, free of charge, after the Family Science program. As a longitudinal program, Iridescent worked with the same eight schools and two museum partners over the five years.² In total, Iridescent served 2,173 participants, including children and families, for 18,628 hours over the five years. In addition, teachers, teaching aides, and museum educators participated in program activities. Table 1 shows survey responses over time, as well as the number of Family Science sessions per series.

¹ Study participants are underserved families in Los Angeles and New York City. Partners include Natural History Museum of Los Angeles, University of Southern California (USC) electrical engineering department, USC Cinematic Arts School, New York Hall of Science, and Cooper Union.

² The schools and museums that participated in the program included Western Avenue Elementary, Frank del Olmo Elementary, Synergy Charter Academy, Betty Plasencia Elementary, Quincy Jones Elementary, Vermont Avenue Elementary, 32nd Street USC Performing Arts Magnet, Norwood Street Elementary, Natural History Museum of Los Angeles County, and New York Hall of Science.

Table 1: Family Science Survey Participants 2011 to 2015

Program Season	Family Science Sessions	Total Survey Responses			Total Survey Responses
		Youth Participants	Adult Participants	Undergraduate Participants	
Spring 2011*	34	236	195	13	478
Fall 2011	45	261	249	22	577
Spring 2012	45	123	67	22	257
Spring 2013	45	137	90	29	301
Spring 2014	45	119	126	21	311
Spring 2015	45	236	156	20	457
Total:	259	1112	883	127	2381

*Data from the Spring 2011 program season was not included in the cross-season analysis due to incorrect data collection

Methods

This section describes the study design, participant sample, and research instruments that were part of the 2015 summative evaluation of Iridescent’s Family Science after-school program.

Design

CCT researchers employed a multi-method research approach to data collection that reflected the structure and goals of the program. Researchers developed a set of instruments during the first year of the program to collect feedback from program participants, including children, parents and adult family members, and Engineers as Teachers students (EasT), as well as school administrative staff and program staff. These instruments were reviewed and modified each year to reflect shifts in the program and in how participants responded to instrument items. Researchers worked closely with Iridescent to ensure that the changes in the programs were being accurately reflected in the survey instruments. Researchers used both qualitative and quantitative data analysis approaches in order to provide a rich and detailed description of the program, participants, and outcomes.

Sample

The study sample includes all family participants and university EasT students, as well as participating school administrators and teachers who chose to engage with the Family Science program during the 20014–15 school year.

Description of student sample

A total of 236 students completed the student survey during the final session of Family Science in spring 2015. Nineteen student surveys were eliminated in the data cleaning process because of missing data and unclear responses on certain items. Data from 217 students is included in this analysis. Fifty-five percent of participants were girls, and 45% were boys.

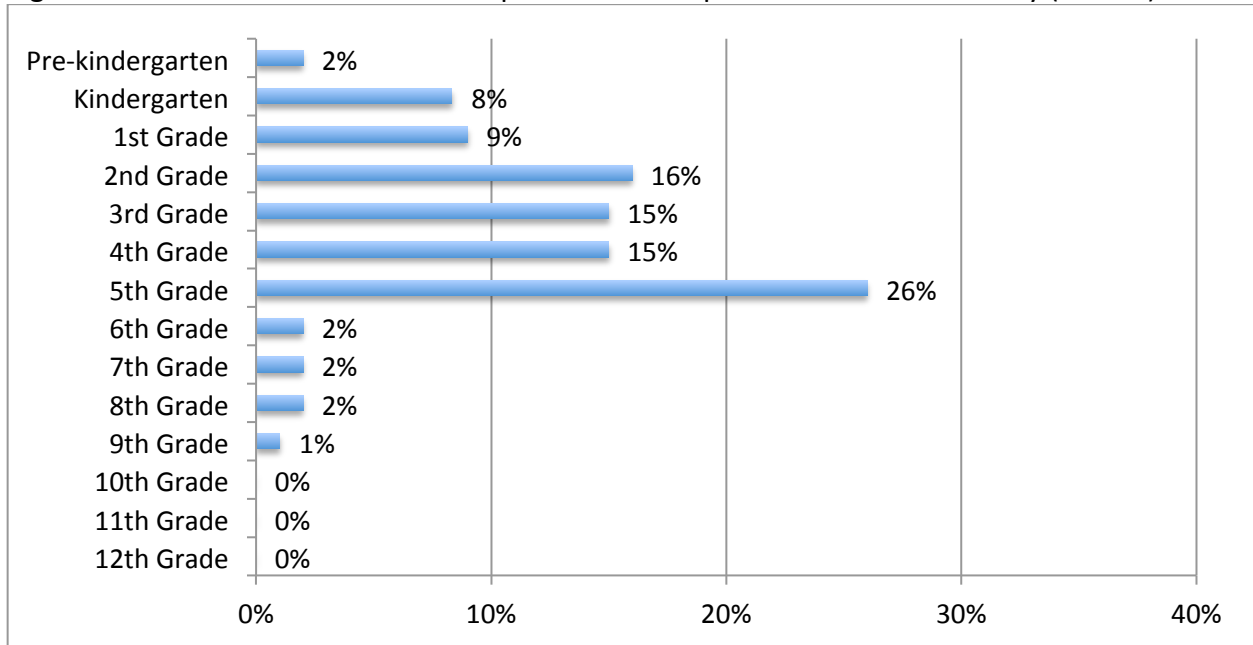
Eight sites (seven elementary schools and the Natural History Museum of Los Angeles County) hosted the Family Science after-school program in the South Los Angeles area, and the New York Hall of Science hosted the program in the New York City Area. Students were recruited from the program’s partner schools in LA, and from schools located near the Hall of Science in New York; in both locations, the focus was on attracting low-income, English- and Spanish-speaking families. The majority of participants were students in California (90%), while the rest of the participants were students in New York (10%). Table 2, below, shows how many student surveys we received from each of the Family Science program sites. Twenty-two students did not indicate what school they attended.

Table 2: Family Science Student Surveys by Site in 2015

Family Science Site	Number of Student Surveys
Western Avenue Elementary	39
Frank del Olmo Elementary	36
Synergy Charter Academy	21
New York Hall of Science	21
Betty Plasencia Elementary	19
Other schools in Los Angeles	18
Quincy Jones Elementary	14
Vermont Avenue Elementary	12
32nd Street USC Performing Arts Magnet	9
Norwood Street Elementary	6
No school indicated	22

Students ranged in age from 2–14 years, with a mean age of approximately 9 years old. A quarter of the students attending the Family Science program were fifth-graders (26%). Figure 1, below, shows the distribution across grade levels of students who completed the final survey.

Figure 1: Grade Levels for 2015 Participants who Completed the Student Survey (n= 192)



In all, 47% of students indicated on the survey that they had been to Family Science in a previous year, and 53% said they were attending for the first time. Table 3 shows in which school years students reported that they had attended the Family Science program.

Table 3: Percentage of Spring 2015 Students who Reported Attending Family Science Sessions in Past School Years (n = 102)

School Year	% of Students
2010–2011	Data not available
2011–2012	43%
2012–2013	55%
2013–2014	77%

Students often attended Family Science sessions with multiple members of their family. When asked who they attended Family Science sessions with, about a quarter of the 106 responding students indicated that they frequently attended with two or more members of their family (23%). A large percentage (76%) reported that their mother brought them to the meetings most frequently, with 25% reporting their father, 16% reporting a brother or sister, and 12% identifying “other” which included responses such as “aunt,” “cousins” and “grandmother.”

Description of adult sample

The Family Science survey was completed by 156 parents or other adult family members during the final session of the five-session Family Science Spring 2015 series. This report provides data from 148 surveys. Seven surveys were eliminated in the data cleaning process because of missing data and unclear responses on certain items. The majority of the surveys were from

participants in California (85%), and the remaining surveys were completed by adults who participated in the New York-based program (15%). Nearly all of the respondents identified themselves as parents or guardians of the child attending the session (94%), with just 6% identifying themselves as “other,” which included responses such as “aunt” and “grandmother³.” The overwhelming majority of adults who filled out the survey were female (85%). Two-thirds of respondents indicated that they spoke Spanish at home (66%), while 40% indicated they spoke English, 6% indicated they spoke a Chinese dialect, 4% indicated they spoke another language (including Bengali, Bangla, Gujarati, and Thai), and 1% said they used American Sign Language. Sixteen percent of respondents indicated they spoke more than one language at home. The majority also indicated that they had Internet at home (88%), and nearly all of them (89%) said they use the Internet to look up information to help their child with science.

The majority of parents learned about the Family Science program through their child’s school (79%), while 19% learned about it through a teacher, 11% heard about it through a friend, and another 12% knew about the program from participation in another Iridescent program. Twenty-six percent of respondents heard about the program through more than one source.

Just over half of parents reported having been to Family Science in a previous year (52%), while the other 48% said they were attending for the first time. Of the families who indicated they had attended Family Science in the past, 30% said they had attended all three of the past school years (2011–2012, 2012–2013, and 2013–2014). Thirteen percent said they had attended two of the last three years, and over half had attended during one of the past three school years (57%). Table 4 shows in which school years parents attended.

Table 4: Percentage of Spring 2015 Parents who Reported Attending Family Science Sessions in Past School Years (n = 77)

School Year	% of Parents
2010–2011	Data not available
2011–2012	36%
2012–2013	55%
2013–2014	82%

Description of undergraduate student sample

Twenty of the 26 undergraduate students participating in the Engineers as Teachers course (EasT) completed the Spring 2015 survey: 18 from the University of Southern California, and two from the New York area (one attended Cooper Union, one attended Bronx Community College). More than three-quarters were seniors (70%), graduating in 2015, while the other 30% were juniors, graduating in 2016. The majority indicated that their major was mechanical engineering (80%), with the other 20% identifying their majors as physics, aerospace

³ While we recognize that not all of the adult participants in the Family Science program identified as parents, for purposes of readability and clarity we have chosen to use the term “parents” throughout this report when referring to this group that includes mothers, fathers, aunts, uncles, grandparents and other guardians.

engineering, chemical engineering, and electronic engineering technology. Only one student identified a minor, alternative energy. The undergraduate engineers were a diverse group, with 40% identifying as Asian, 35% identifying as White, 15% as Latino/Hispanic and 10% as African-American. Students who matriculated into the Engineers as Teachers class, chose to take the course as a technical elective credit which counts towards their engineering degree.

This cohort of EasT students had a good deal of experience teaching non-family members in various settings. Seventy percent of the engineering students had experience teaching non-family members. All but one of those students had taught science, engineering, or math to non-family members. Of the students who had taught non-family members before, 77% had taught math, 62% had taught science, and 54% had taught engineering. The most commonly cited teaching experiences were tutoring (36%), working at a summer camp (21%), being a teaching assistant (14%), and teaching in a K–12 setting (14%). Most students also had some experience working with a team of engineers or scientists to complete a project (90%). Fewer than half the students (45%) had any experience creating science-, math-, or engineering-related content, but a little more than half (55%) did have experience speaking in public on at least one of those three topics.

Instruments

EDC researchers used a variety of instruments to collect data during the summative year of the Be A Scientist research study.

Student survey

EDC developed a student survey to collect information about students' interest in science, technology, engineering, and math (STEM), as well as their experience in the Family Science after-school program. Spanish and English versions were available and were distributed and collected by Iridescent staff during the final Family Science session. Because many participating children were too young to complete the survey independently, parents often helped. More specifically, children were asked questions about their attendance at Family Science, their interest in STEM-related activities, and impacts on their knowledge and behavior since participating in the program. They also were asked to draw a picture of their favorite building/construction activity.

Parent survey

EDC developed a parent survey to collect information about families' backgrounds, interest in STEM, and experience in the Family Science after-school program. The survey was administered during the final Family Science session. Spanish and English versions were available and were distributed and collected by Iridescent staff. Parents were asked to rate various statements about STEM activities and careers and were asked to indicate the frequency of STEM activities they engage in at home, as well as other questions about their experiences with the Family Science program.

Engineers as Teachers student survey

EDC researchers developed an online survey for EastT undergraduate engineering students to collect information about their academic background, their prior experience teaching STEM, and program impacts on their skills and interests. The online survey was distributed through a link that Iridescent staff shared during the final session of the EastT course.

Engineers as Teachers student focus group

EDC researchers interviewed a subset of EastT undergraduate engineering students to obtain additional information about their experiences designing and teaching the five-week program to families, and to hear their thoughts about the program in general and its impacts on their skills and interests. The interviews were conducted at the Iridescent office.

Participant interviews

EDC conducted two types of interviews with parents and students during the summative year of the research study. Interviews with returning parents and their children were organized and scheduled by Iridescent staff and were held over the course of one afternoon at the Iridescent offices. The purpose of these interviews, conducted in both English and Spanish, was to better understand the impacts on families who had participated in the Family Science after-school program for five years. The interviews included questions about parents' perceived impacts of the program on their family activities in relation to science, their children's academic performance, and their children's interests in and outside of school in science and related activities. Parents and students also reflected on their experience in the program and shared challenges and recommendations.

In addition to these formal interviews, EDC researchers conducted brief informal interviews with adults and students during the final Family Science session. EDC researchers conducted these "opportunistic interviews" with adults and children who were recommended by Iridescent staff, and who were available to talk during a Family Science session. Parents were asked about their thoughts on the program, why they chose to attend, how they learned about it, and what kinds of science activities they did at home.

School administrator and teacher interviews

We conducted Interviews with one principal, one assistant principal, and two teachers over two site visits to observe Family Science sessions at one school. These interviews were conducted during the Family Science sessions. Interview questions focused on teacher and administrator perceptions of the impact of Family Science on children and families informally, and also in the context of classroom activities.

Museum partner interviews

EDC researchers conducted interviews with two museum staff members from the Natural History Museum of Los Angeles and the New York Hall of Science Museum in New York City. The interview in Los Angeles took place in person, and the New York interview took place over the phone. Interview questions focused on the museums' staff's involvement with the program,

their collaboration with Iridescent, their perceptions of the program’s impact, and any lessons learned along the way. The interviews were conducted after the Family Science sessions were ended.

Family Science observation

EDC researchers conducted observations during a midpoint and final Family Science session at two sites in Los Angeles and a single site in New York City. The observations were used to gather information about the structure and content of instruction and to talk with students and parents about their experiences.

Limitations and Constraints

This study has the following limitations and constraints that should be taken into consideration when reading the information presented in the Findings section below.

The participants in the Family Science program are a self-selected group and chose to engage in the accompanying lessons and activities; these respondents are unique and therefore not representative of the population as a whole. The responses that are included in this report are generalizable to this self-selected group, but not to the populations of parents, students, or engineering students generally.

In some cases, parents may have completed children’s surveys, and these survey results may not always accurately represent children’s responses.

Findings

Student Experience

Overall, students participating in the Family Science after-school program are interested in and engaged with science- and engineering-related activities both in and outside of school. Nearly all students from the 217 surveys said they like studying science in school (92%, N = 211), while three-quarters noted that they ask a lot of questions in school (75%, N = 208). Notably, responses from returning and first-time students varied widely on this question. Eighty-one percent of returning students agreed or somewhat agreed that they ask a lot of questions in school, while only 68% of new students agreed with the statement—a statistically significant difference of 13 percentage points ($p < .05$). Students indicated that outside of school they were likely to visit zoos, museums, nature centers, and parks to observe things (92%, N = 208), while three-quarters said that they like to watch TV and movies about science (77%, N = 211). Students’ responses on this item also varied

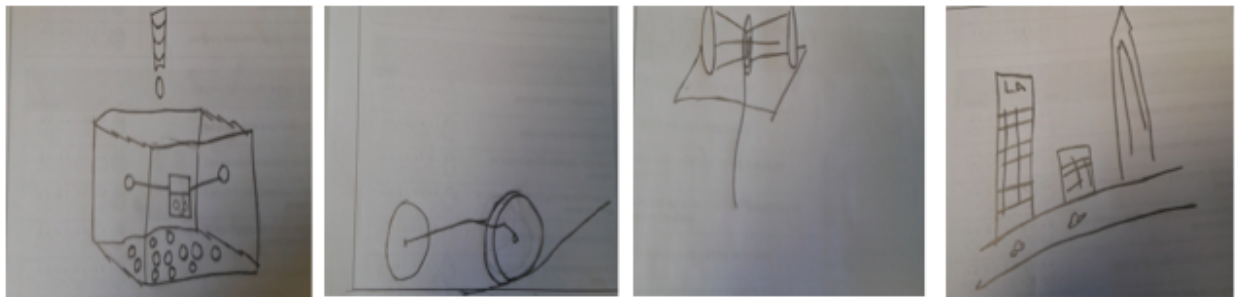


Children in Los Angeles sketch their design idea first before gathering materials to build their prototype.

by whether or not they had participated in the program before. In this instance, only 70% of returning students agreed that they like to watch science-related TV shows and movies, while 82% of first-time students agreed with the statement—a statistically significant difference of 12 percentage points ($p < .1$). While we can't be certain why students responded this way, we can speculate that perhaps that after being given access to hands on projects and activities through the Family Science program, that they became less interested in passively watching someone else do science related activities on a screen. This is an area worthy of further exploration and a potential future research study. Students describe engaging in scientific thinking practices such as building things (95%, $N=209$) and touching things to learn about them (87%, $N = 210$). Finally, 85% of students agree or somewhat agree that they would be a good scientist or engineer someday ($N = 208$).

Researchers also analyzed student responses by gender to see if there were any noticeable differences. The biggest differences in student outcomes came in response to whether they like to touch things to learn about them. Nearly all of the girls in the program agreed or somewhat agreed with this statement (95%), while only 78% of the boys in the program agreed—a difference of 17 percentage points ($p < .001$).

EDC researchers interviewed eight students who had participated in Family Science for the past five years. When asked what they liked most about coming to the program, they had three principal answers: learning about new things, building and making things, and spending time with family. One 5th-grade girl said, “[I like] learning things I didn't know before. Like stuff about gravity, kinetic energy, and how to make things from scratch. I try making stuff on my own around the house.” A 2nd-grade boy answered, “What I like most about the Family Science was that the family also comes with you.”



5th grade girl, Egg drop activity 4th grade boy, Building a rover 5th grade girl, Designing a crank 2nd grade boy, Buildings

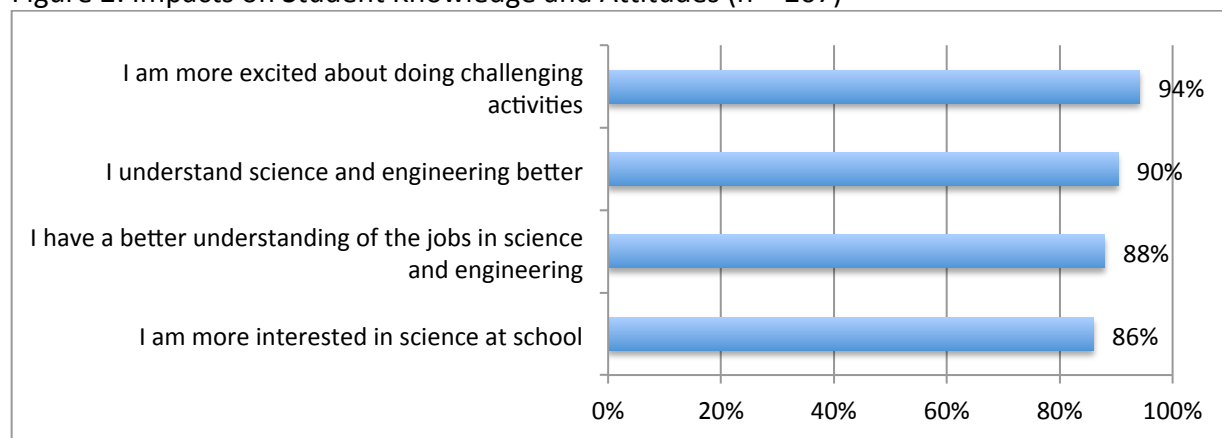
On the final survey, students were asked to draw a picture of their favorite building or construction activity and to describe what was happening in their picture. Students drew a wide range of images of varying detail and themes. Some of the favorite activities they drew included constructing a skyscraper or other building, the egg drop activity, designing a crank, and creating a car or rover.

The most common drawings included an image of a building (16%). In addition to objects, students also included pictures of actions. The most common action described was building or making something (15%). Other images included something falling, picking up or grabbing something, and pulling something.

Impacts on Student Participants

Students indicated that participating in the Family Science program had impacts on their knowledge, attitudes, and behaviors. Figure 2 shows the percentage of students who agreed or somewhat agreed with statements about changes in their knowledge and attitudes.

Figure 2: Impacts on Student Knowledge and Attitudes (n = 207)



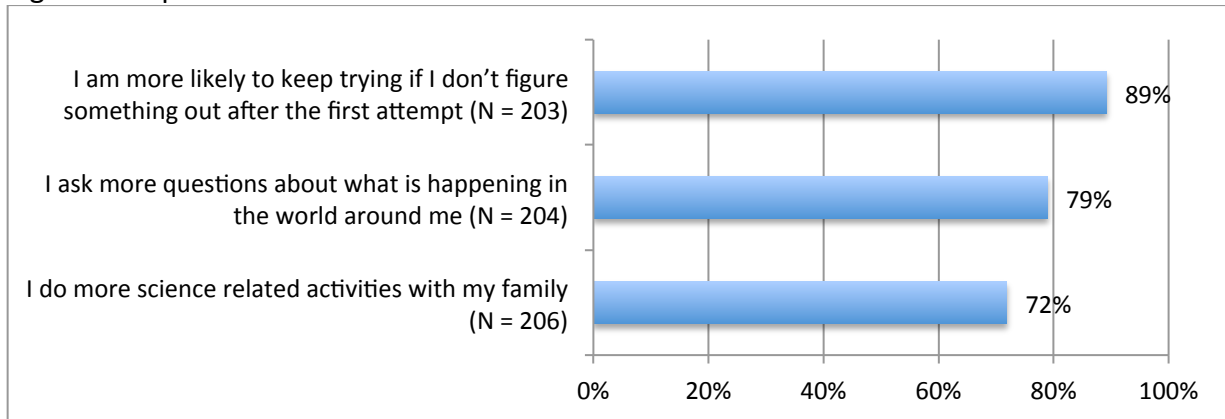
The vast majority of students indicated that they understand science and engineering better (90%), and that they have a better understanding of what jobs are available in those fields (88%). The five-time returning students we interviewed shared similar sentiments. When asked what they wanted to be when they were older, seven out of eight students mentioned a career in science or engineering; five of those students said their experience with Family Science had influenced what they want to do. Three students said they wanted to be scientists, two students wanted to be doctors, one student wanted to be a biomedical engineer, and one student said she wanted to be a science teacher. When asked what about the Family Science program made her want to be a scientist, one student said, “because building stuff is awesome and you could try to use it and try to build something new in the world.”

Students also responded that they were more excited about doing challenging activities (94%) and that they are more interested in their science class at school (86%). Returning students were slightly more likely to agree with the statement about being excited to do challenging activities, with 98% agreeing or somewhat agreeing, while only 91% of first-time students agreed with the statement—a difference of 7 percentage points ($p < .05$). We asked seven out of the eight students whether participating in the Family Science program has helped them do better in school. All seven students agreed that participation in the program had indeed helped them in school. Two students talked about learning relevant content about circuits and energy that they could apply in their classrooms. One student said he was getting better grades and

another girl got extra credit in school for sharing her Family Science projects with her teacher. One mother said that her daughter is submitting higher quality work at school because of participating in the Family Science program. “They have done better projects at school because she participated in the Family Science Program. The program gives her ideas that she didn’t have before. For example, electricity, she understood it better in school because she was participating in Family Science.”

Figure 3, below, shows students’ self-reported impacts of the program on their behavior. They report being more engaged in practices of scientific thinking, such as persistence (89%) and questioning (79%). EDC researchers identified differences between how boys and girls responded to the question about doing more science-related activities with their families. Seventy-six percent of girls agreed or somewhat agreed that they were doing more science-related activities, but only 66% of boys agreed with the statement, a difference of 10 percentage points ($p < .1$).

Figure 3: Impacts on Student Behavior



The students we interviewed shared anecdotes that echoed these survey responses. One 5th-grade girl described how Family Science helped her think like a scientist at school. “When we build something and it’s not made correctly, we have to keep on trying to get it because you have to have patience to do it. And my teacher says that scientists don’t build things at one try. They take many tries to build it.” A mother also talked about her son being more patient and independent. “When he was younger, it seemed he would always get anxious and hyper and rush his work and wouldn’t grasp the ideas. Now he tries to do it a bit better. And now he doesn’t need me to help him, he does it by himself.”

Challenges and Recommendations

A small group of students who had participated in the Family Science program for multiple years was asked if they wished the program were different in any way. None of the six students asked said they would change anything. One 2nd-grade boy said, “I want it to stay the same.” All students shared the sentiment that they wished the program were continuing. One 5th-grade girl said, “I’m going to miss doing projects, learning different kinds of things that you

need to be a scientist and that you have to keep on trying no matter what comes after that, but you have to keep on trying to build the projects. So I'm not going to get to do it as much, because I'm not going to have the project to keep on trying on."

Looking across all 217 survey responses, the vast majority of students would recommend the Family Science program to a friend (96%). When asked how they would describe the program to a friend, students used words like "amazing," "awesome," "cool," and "exciting." But by far the most common word they used was "fun"—44% of the written descriptions used that word. A quarter of students also talked about the learning they did around science and engineering topics (23%). One 8th-grade girl at Synergy Charter School wrote, "It is really cool because you get to build things and you learn new things, so that in science class when kids don't know the answer, you'll know it." The quotes below are representative of the general sentiments among the 217 students who completed the survey.

"It is a wonderful place where you learn how to engineer. They also want you to have fun. They give you free food. You could also take your family there. I love it."—5th-grade girl at Western Avenue Elementary

"I will tell him or her that it is fun and that you learn more. And from your mistake you learn."—5th-grade girl at Frank del Olmo

"It is really fun and creative. I love going there. I learn more every week."—4th-grade girl at Synergy Charter Academy

Parent Experience

Overall, the adults participating in the Family Science after-school program are engaged in STEM-related activities, think positively of STEM-related careers, and are involved in their children's schools. Figures 4a and 4b, below, show parents' interest in certain science-related activities, as well as how frequently they engage in those activities.

Figure 4a Parent Expressed Interest

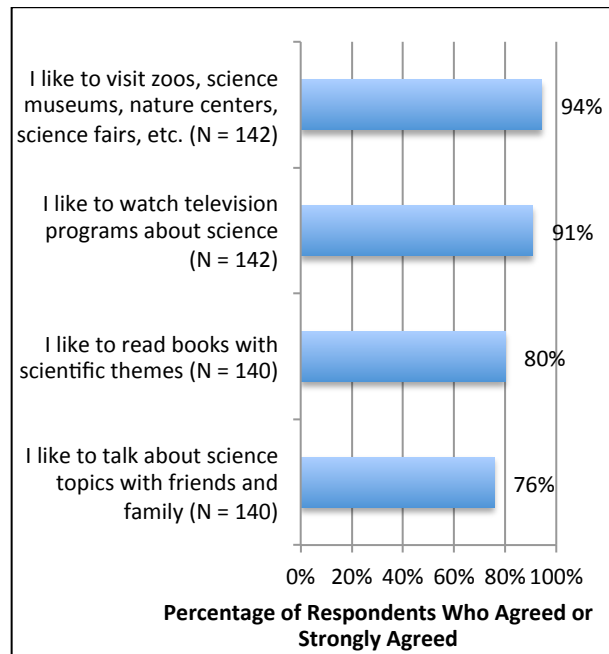
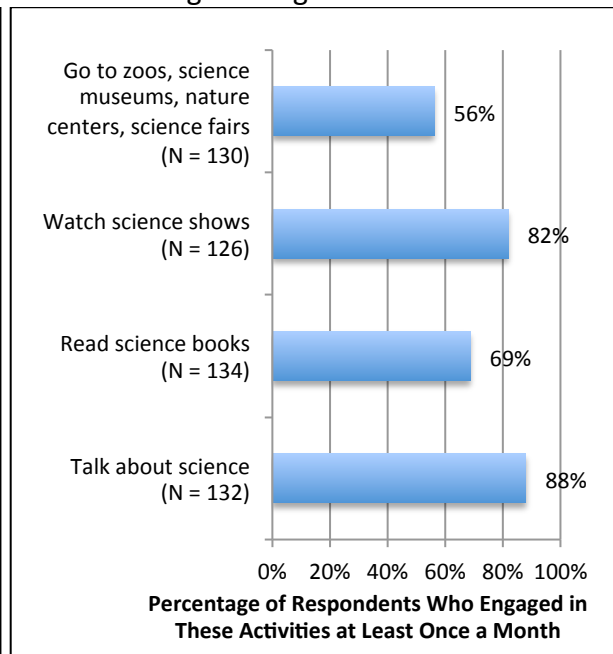


Figure 4b: Frequency of Science and Engineering Activities



Of the 148 surveys analyzed, nearly all of the adults (94%) agreed or strongly agreed that they like to visit zoos, science museums, nature centers, science fairs, and other similar institutions, and just over half of respondents (56%) said they go to these places once a month or more. While some families are able to attend science events and visit science institutions frequently, others may not have the option due to financial constraints and the transportation challenges that these trips present. In addition, there are likely other constraints, such as competing out-of-school activities that children are involved in, and there is also a limit to how frequently one can visit a museum or zoo. Each of these affects the frequency of these visits and therefore a report of frequency of visiting these locations may not accurately represent an interest or desire to visit. In contrast, 91% of adults reported that they like to watch television programs about science, and 82% reported doing this once a month or more frequently. Responses on this item differed among returning and first-time parents, with 95% of returning parents agreeing or strongly agreeing that they like to watch television programs about science, compared to 87% of first-time parents—a difference of 8 percentage points. (This is not statistically significant, but it may suggest a potential shift in behavior.) Similarly, 80% of respondents agreed or strongly agreed they like to read books with scientific themes, and 69% report reading science-related books once a month or more. Parent responses around the frequency with which they watched science-related TV shows and read science books varied by parent group. Returning parents were more likely to indicate that they watched science-related TV shows (86%) and read science-related books (72%) at least once a month than were first-time parents, who reported watching science shows (78%) or reading science books (65%)—a difference of 8 and 7 percentage points, respectively. While this is not statistically significant, it suggests a difference in behavior between these two groups. Interestingly, while three-quarters (76%) of adults say that they like to talk about science topics with friends and family, 88%

report actually doing it once a month or more. This, perhaps, reveals that while not all adults like talking about science, they do see some value in doing it with their children or other family members.

Family Science adult participants think highly of STEM-related jobs and careers, as evidenced by the fact that very few described STEM jobs negatively. Under a third agreed or strongly agreed that jobs in STEM fields are very complicated (30%, N = 124) and hard to find (31%, N = 137). Less than 20% of participants agreed or strongly agreed that these careers were not interesting (18%, N = 119), not secure or stable (16%, N = 123), and not social (15%, N = 118). Notably, it was on these three items that returning and first-time parents differed most strongly. Returning parents were *twice* as likely to agree that jobs in STEM fields are not interesting, not secure or stable, and not social. While this result is somewhat surprising, it is possible that returning parents have a more nuanced perception of the reality of working in STEM jobs. It is possible they have been exposed to more scientists and engineers or have done more research about careers in those fields. As with any job in any field sometimes the work can be uninteresting, unstable, and not social. Table 5 shows the degree to which parents’ answers differed ($p < .1$).

Table 5: Parent Perceptions of Jobs in STEM Fields

I agree or strongly agree that jobs in STEM fields are...	Returning parents (n = 77)	First-time parents (n = 71)
Not interesting	24%	11%
Not secure or stable	22%	10%
Not social	21%	9%

The parents of children who participated in the Family Science program report being highly engaged at their children’s schools. Eighty percent say they are involved in their child’s school (N = 135), and 81% say they never miss a parent/teacher conference (N = 139). Two-thirds reported that they regularly attend PTA meetings (64%, N = 132). Responses to this item varied by returning and first-time parents. Seventy percent of returning parents agreed or strongly agreed that they regularly attend PTA meeting while just 56% of first-time parents agreed with the statement—a difference of 14 percentage points ($p < .1$). In addition to engagement at school, many of these parents also supported the implementation of the Family Science program during after-school hours. Iridescent staff trained 30–35 parent volunteers who were leaders during the Family Science program, helping to recruit families, set up food, distribute materials, and clean up at the end of each session.

Both formal and informal interviews were conducted with parents to inform project activities and to document their experiences. The interview questionnaires complemented the surveys by providing additional information on parents’ participation in the program. Not all parents responded to all questions.

Parents who had attended Family Science sessions for five consecutive years shared what they enjoyed most about coming to the program. Overall, the parents like being able to do something together as a family. One mother of a 5th grader said, “What I like the most is I get to sit with my kids and work with them, which we hardly do at home. So I say that’s why it’s called Family Science, because it’s the family that gets together and builds stuff, stuff that you usually don’t get to do at home that often. So it is a time where you spend time with your kids and doing what they like.” Parents also liked watching their children working through challenging projects. A mother of 5th-grade twin girls shared that what she enjoyed most about attending Family Science was, “seeing their faces when they learn something new or whenever they see something that interests them ... seeing them try, and whenever they get something wrong, they don’t cry or they don’t put on that face, that sad face. They’re like, ‘Oh, let’s try it again, let’s do it again. We have to do this.’ ”



Families work on a design challenge at the Family Science after-school program in Los Angeles.

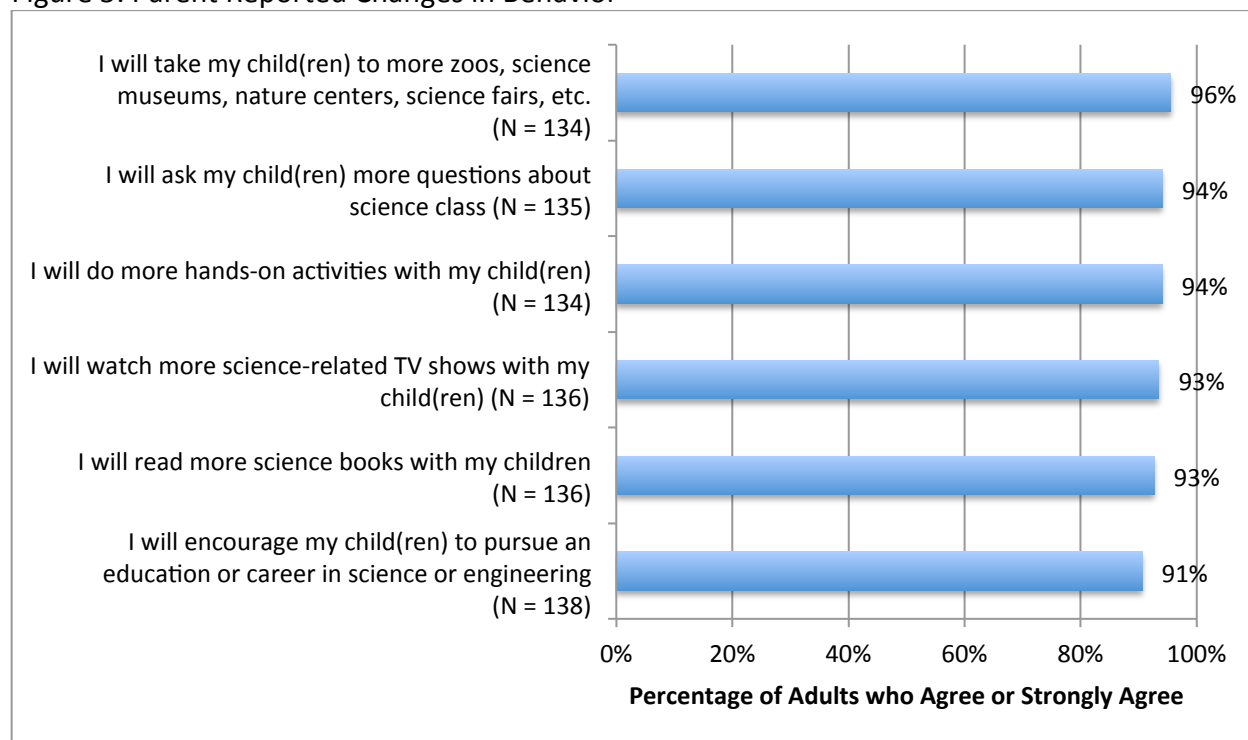
Similar sentiments were expressed by new participants who had been in the program two years or less. For parents, fostering their child’s interest in science is top priority, and they feel that a program like Family Science helps children learn new ways to understand the world. As one mother at Synergy Charter Academy stated, “My daughter has always been a good student, but this program allows her to be creative and she enjoys the hands-on component of it.”

Parents also like that their children are learning from student engineers and are getting first-hand experience building things with them and getting feedback from them. One mother at the New York Hall of Science felt that, “It is important for our kids to be exposed to things they don’t normally experience in school.” Another mother at Synergy Charter Academy said, “It gives my kids an activity to do, rather than them being at home watching TV. This program helps them exercise their minds.” Despite parents’ varying experiences, they all praised the program, as their total experience with the Family Science program has been positive.

Impacts on Parents

Overwhelmingly, parents report positive changes in their behavior since participating in the Family Science program. Over 90% of all respondents agreed or strongly agreed that, since participating in the program, they would engage in more science-related activities, such as visiting zoos, reading books about science, watching science-related TV shows, and doing hands-on science activities at home. Similarly, 94% indicated that they would ask their child more questions about science class, and 91% said they would encourage their child to pursue an education or career in science or engineering. Figure 5 shows the complete breakdown of participant responses.

Figure 5: Parent Reported Changes in Behavior



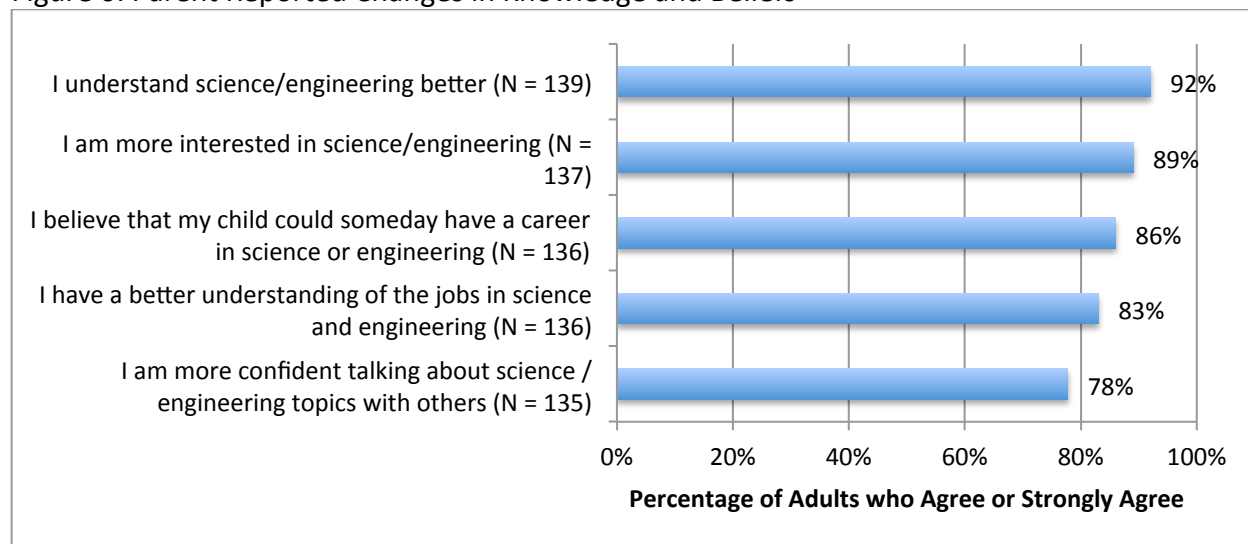
Parents who had attended Family Science sessions for five years shared anecdotes about changes in their family's behavior since participating in the program. One mother talked about doing more activities together generally. "I see we're more close together than before, because of the times that we spent together. So now we try to do more together stuff at home, and not just the projects, like any other stuff, but we always try to do it together." More specifically, three of the four parents said they go to the science museum and zoo more frequently, and one parent described watching more science-related documentaries since participating in the program. Three of the four parents interviewed also talked about doing more hands-on projects at home, particularly using everyday household items. One mother of three daughters described the changes she saw at home:

"We have gone to many, many, many, sessions, they usually tell us about how to use different materials and this has given us ideas for school projects. [My daughter] uses toilet paper rolls and other materials to do projects at home and for school. Materials that otherwise would go in the trash. The family has a big box where they collect materials to be used in [her] projects. Before, she didn't do as many projects. Now she uses the materials to do projects all the time. They are doing more projects at home, there is less material going into the trash, cardboard, toilet paper rolls, aluminum."—
Mother of three, and a five-year Family Science participant at Synergy Charter School

Over three-quarters of parents also reported changes in certain knowledge and beliefs since participating in Family Science. Ninety-two percent of respondents indicated that they

understand science and engineering better, and 89% said they are more interested in those content areas. Figure 6 shows responses across five indicators.

Figure 6: Parent Reported Changes in Knowledge and Beliefs



Returning parents were more likely to agree or strongly agree that they are more confident talking about science and engineering with others than were first-time parents. Eighty-two percent of returning parents agreed with the statement, compared to 74% of parents who were new to the Family Science program—a difference of 8 percentage points.

The five-year returning parents shared specific examples of increased knowledge since participating in the Family Science program. One mother talked about learning new things such as new vocabulary words. Another mother talked about her husband learning things at Family Science that he can actually apply to his job. “There are many things that [Family Science] teaches us that help in the day-to-day. My husband works with robots, and what he learns in Family Science helps him in his work.”

Challenges and Recommendations

Scheduling was the primary challenge mentioned among the veteran parent group. Families are usually juggling schedules for multiple children, and making two hours available in the evening can be difficult. But the parents agreed that they made time to attend the sessions because they and their children enjoyed participating. One mother said, “We always have stuff to do and, since it’s in the evening, so we always try to be there on time, most of the time, which we did. We were there [every] day all the time. And since I noticed my daughter was very interested in joining the program and she didn’t want to miss, not one, so I had to make the space for it.”

Parents also had some noteworthy recommendations.

Provide more information about engineering in the real world

“Maybe show more slides about how engineering is important in the real world. Maybe show different careers engineering has to offer. My kids would ask what schools are good [for] science and engineering, maybe that info would help engage the curious minds. And one more thing, kids like fun facts! It’s all about getting them engaged into the activity.”—Female parent/care provider from Western Avenue Elementary School

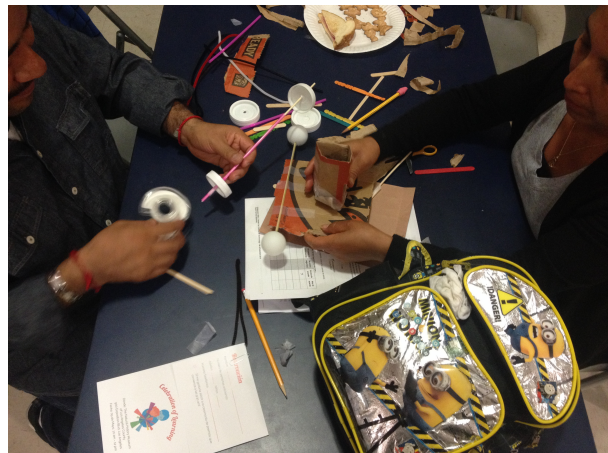
Connect Iridescent alumnae to the University of Southern California admissions office

“I wish that participating in Family Science could help the kids get into USC, or that it gave them some points or a little leg up to get looked at or get in the door at the university.”—Mother of three and a five-year Family Science participant from Synergy Charter Elementary

Have instructors share with students an engineering project they completed

“I would have liked to see at the end of the session one big thing that the engineers did themselves. I think that would have been very nice. There was this one time where I think ... the theme was like racecars. And at the end of the five sessions, they took one of those racecars and they did a demonstration. And the students actually liked that. My kids liked that.

They were very excited about knowing that at the end of the five sessions, they were going to have this racecar. They were going to be able to see it. So that would have been nice if it would have been like for all five [years]. Maybe at the end of the fifth session, show something that the actual engineers built themselves and it did work.”—Mother and five-year Family Science participant from Quincy Jones Elementary School



Families complete a design challenge at the Family Science after-school program in Los Angeles.

Differentiate the difficulty of the lessons to ensure all age levels will be challenged

“Maybe the project, sometimes to me, they seemed a little bit too easy. They need, like, something more like that pushes them a little bit harder. Something that gets them to think more.”—Mother of two girls and a five-year Family Science participant from Synergy Charter Elementary

To facilitate project completion, start the session by asking questions about the previous design challenge

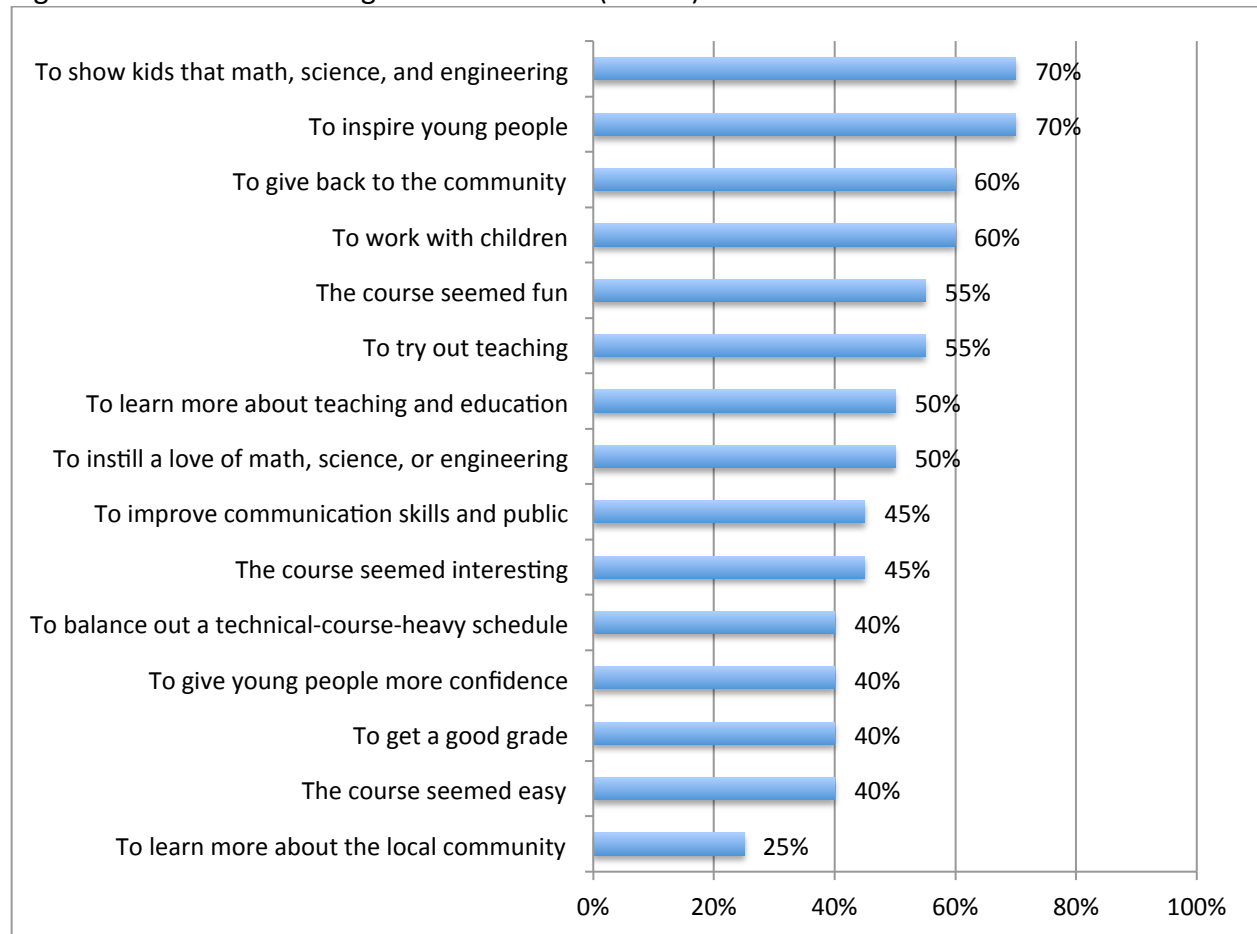
“[The instructors] should ask [about] the project ‘last week,’ because [the kids] will do all the unfinished project at home; otherwise they wouldn’t do any unfinished projects at home.”—Female parent/caregiver from the New York Hall of Science

Engineering Student Experience

An overwhelming majority of the undergraduate engineering students reported having a positive experience in the Engineers as Teachers course. They generally enjoyed working together and co-facilitating the workshops, and engaging in meaningful interactions with students and parents. Eighty percent of the engineers would recommend the class to a peer using words like “fun” “rewarding” and “interesting” to describe the course. They described it as “a great opportunity to learn outside the usual classroom,” “a good break from typical engineering classes,” and “fun and challenging in a way engineers typically aren't exposed to.”

Engineers reported hearing about the course through a variety of avenues, and cited a number of different reasons for ultimately taking the course. A third of students heard about the class through a student advisor (35%), others through an Iridescent team member (25%), and others from a friend (15%), an Engineers as Teachers alum (10%), or from a professor (10%). The most common reasons for taking the class included showing children that math, science, and engineering are fun (70%), and inspiring young people (70%). Figure 7 shows the full range of motivations.

Figure 7: Reasons for Taking the EastT Course (N = 20)



The aspects of teaching the Family Science sessions that the engineering students found most rewarding aligned closely with their reasons for enrolling in the course. Seventy percent of the engineers indicated they took the course to inspire young people and to show them that STEM subjects are fun. Through open-ended written responses, EasT students shared what they found most rewarding about teaching; many wrote that it was seeing the children become excited about learning STEM topics, watching them have fun working on their design challenges, and inspiring them to come up with creative solutions. Most EasT students came to the program with at least some prior experience with tutoring or working with students, and were often motivated to serve as volunteers in order to gain more experience. A selection of quotes from engineering students, below, highlights what they found most rewarding about their teaching experience.

“Being able to teach the kids about math and science was awesome! I loved when I was able to see them really get interested about what they were learning!”—EasT senior in mechanical engineering

“Interacting with children, seeing their effort and seeing them having fun while building things [was most rewarding].”—EasT senior in mechanical engineering

“I found just teaching the kids about the concepts to be the most rewarding, especially when they couldn’t figure something out, go back and redesign, and see that their design then works. It is so fun for me to see the students see their designs succeed in our design challenges. It’s also really rewarding seeing the kids bring back their designs from previous weeks. This means that they were really interested in that topic and wanted to show us what they’ve added at home.”—EasT senior in mechanical engineering

Impacts on EasT students

The undergraduates also shared what they gained from participating in the EasT course. They rated the EasT course and training very highly and appreciated that it allowed them to gain teaching skills and confidence in relaying what they do. The three most common responses had to do with improved verbal communication skills, experience teaching and working with children, and engagement and understanding of the surrounding community. Specifically, students summarized the impact on their skills and interests in the following ways.

Improved communication skills

“I’ve gained a better understanding of how to work with people of different backgrounds and to communicate difficult subjects in a more effective manner.”—EasT senior in mechanical engineering

“This time around I really learned how to present information in a clear matter. ... I also learned that cutting out information that isn’t very concise is a great way to be more clear. Even if you really like what you’re saying, if it is too much of a tangent, you will lose your audience, especially the younger kids. I find myself utilizing these concepts in

everyday conversation with people and in my presentations I am giving in school to finish up my degree. I can't wait to use it again the next time I teach."—East senior in chemical engineering

Better understanding of teaching practices

"I gained an understanding of what it takes to get children excited about learning STEM. It takes an entirely different approach than teaching adults, otherwise their attention is lost."—East junior in mechanical engineering

"I gained so much from this course! I really think that my teaching skills were increased, and I loved that I was able to get a hands-on experience of teaching!"—East senior in mechanical engineering

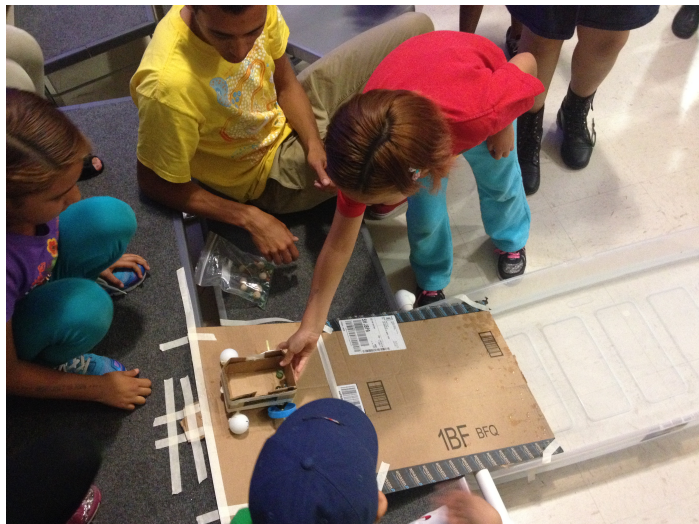
"There is no other class that I have seen at USC that comes close to giving you that kind of experience other than extracurricular activities. This is the one class/program that I would definitely recommend if someone was interested in teaching science to young kids."—East senior in mechanical engineering

Increased knowledge of the local community

"I gained a lot of knowledge about the local community and the families that live here. I learned that they do not live in the best of situations, but these kids are still bright and intelligent. If we could just give them a chance to learn about STEM, some are very interested and it might spark something in them that would have them pursue a STEM career. Without introduction to STEM, they might never get involved with it or find it interesting or fun."—East senior in mechanical engineering

"I learned a lot about the community around USC. The school kids need a lot of motivation to get into science and engineering. They need to realize that science is not merely solving problems on paper, but it involves thinking about creative solutions to complex real problem."—East junior in physics

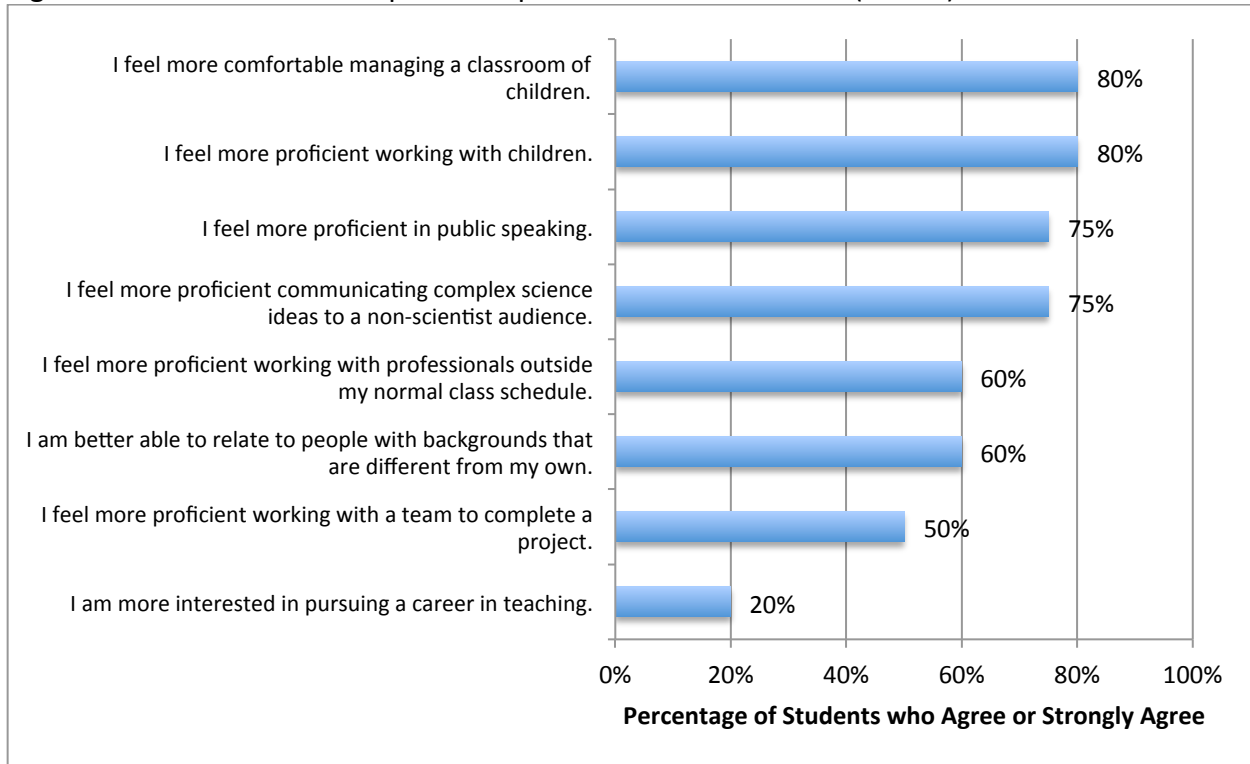
The undergraduate engineering students were asked to rate to what extent they agreed with a number of statements about their experience with the EastT course. Nearly all of the engineers (80%) reported that, since participating in the EastT course, they feel more comfortable managing a



An EastT undergraduate student in Los Angeles helps a student test her design while others look on.

classroom of students and that they feel more proficient working with children. Three-quarters of students (75%) reported improved communication skills, specifically in public speaking and communicating complex science ideas to non-scientific audiences. Only 20% of the undergraduate engineers reported being more interested in pursuing a career in teaching. Figure 8 shows the engineers' responses to all of the statements.

Figure 8: EasT Student Self-reported Impacts of Personal Growth (N = 20)



Challenges

The undergraduate engineering students reflected on what was challenging for them about the EasT course, as well as teaching the Family Science sessions. In terms of the course, many students listed “coming up with a design challenge” as the most challenging aspect of the course. One EasT senior in mechanical engineering described the challenge: “The hardest part was coming up with good design challenges. Finding something that had multiple solutions and wasn’t too difficult for the kids was really tough.” An EasT junior in physics explained why creating a good design challenge was important: “Making an actual design challenge was very difficult for me. I had never built for fun as a kid. Majority of my time was spent in solving problems on paper. I realized the importance of these design challenges and how the science taught through them stays with the kids in future.”

Some students mentioned that collaborating with peers and across institutions was a challenge. An EasT senior in mechanical engineering wrote, “[What was most challenging about the EasT class was] supervising my group, making sure we have everything we need for a successful presentation.” Other students described the hefty workload and large time commitment as

challenges. A third EasT senior in mechanical engineering explained, “[What was most challenging about the EasT class was] probably the workload. I spent a lot of time doing work for this class, but in the end it was worth it and helped me get more out of this experience.”

Challenges related to teaching the Family Science sessions included managing the large group of families, getting and maintaining students’ attention, and communicating complex concepts in understandable ways. Many of the EasT students mentioned “classroom management” as the most challenging aspect of teaching Family Science. They wrote that the biggest challenges were, “Getting the parents’ and kids’ attention during the presentations,” “Managing large numbers of children,” and “Trying to keep the classroom under control.” One EasT chemical engineering senior described getting and maintaining participants’ attention as a multi-pronged challenge: “The kids were really well-behaved and NYSCI offered us a lot of help with the large class sizes. I think projecting my voice and keeping the attention of all the kids simultaneously was the hardest part of teaching this class.” One EasT mechanical engineering student succinctly explained the communication challenges of teaching Family Science: “I think trying to make the material easy enough for the students to understand, but difficult enough so that they are challenged and learn something new, was the most challenging thing about the class.”

Iridescent staff observed an additional challenge that the EasT students did not mention. The staff talked about the challenge of working in an unpredictable setting, like a school where things come up that can impact the Family Science program, even when the session has been meticulously planned and thought out. “We try to anticipate as much as possible, but there’s always something that pops up almost every day. I think for the EasT students, that’s the biggest hurdle. They really do not understand why things aren’t laid out exactly how they want it. Even though we try to teach them that, it’s still hard for them.”

There was one suggestion for improving the EasT program: The coursework could be expanded to provide engineering students with more opportunities for in-depth study. One EasT mechanical engineering senior explained that he “wishes there was a way to incorporate more real engineering into the program and have students learn and explore engineering concepts in-depth at a college level, and do some project-based work so that they would be learning some more engineering.”

Teacher and Administrator Experience

EDC researchers interviewed one principal, one assistant principal, and two teachers from one of the participating schools. The interviews were conducted during the Family Science sessions. Both teachers were very supportive of the program, encouraged their students to attend (one teacher offered extra credit to his students if they attended all five sessions), and encouraged families to bring their children. The teachers supported the program’s activities by helping parents and children with understanding the design challenge posed by the EasT students, helping with securing materials, translating from English to Spanish (one teacher was able to do this for several children and families), and attempting to bring some of the Family Science activities and overarching goals into classroom activities.

Administrators noted that bringing a program like this in to a school is challenging because there are so many competing demands for staff time and attention. The fact that the program was “delivered” ready to go—the Be A Scientist staff had organized materials, provided the design booklets that students use, recruited the EasT students, and even distributed pizza to all attendees—made the program much more desirable. The principal noted that there was a period of less organization in the program last year, and this made the program almost too complex for his school, but once some of the organizational issues were addressed everything worked smoothly and he was glad that his school had stayed with the program.

Impacts

When asked if they saw a difference in engagement or performance in class by those students who participate in the Be A Scientist program, both teachers said it was hard to tell because they try to infuse so many things from the program into their teaching for all students. In this way, the program seemed to have an extended impact on teaching beyond the program’s target audience of children and parents.

Challenges

Both teachers talked about how hard it is to integrate science activities, such as those introduced during the Family Science experience, into their classroom instruction. This is due to lack of time and lack of the kinds of materials required—for example, access to enough supplies such as wheels, pipe cleaners, plastic tubing, etc., that EasT students and Iridescent staff made available for Family Science activities.

Both the principal and assistant principal stressed that having a program like this in a school is challenging because of the organizing that is required. At this site, the school staff provided photocopying for the program, ensuring that families and children all had photocopied surveys available in Spanish or English. They also organized the space, setting up tables and then cleaning up the remains of pizza and drinks and the activity materials after the session ended.

In addition, schools recruited families, and some provided teaching assistants to help with the program and to assist with translations, even though the Los Angeles Unified School District has a translation service available that provides a translator and a set of headsets for all families asking for English/Spanish translation. However, many staff noted that this person always left early, along with his equipment.

Program Partner Experience

EDC researchers conducted interviews with two museum staff members from the Natural History Museum of Los Angeles (NHM) and the New York Hall of Science Museum in New York City (NYSci). One of the staff members had been with the program all five years, while the other staff member we spoke with had been involved in the program for just one year. Both women were positive and supportive of the program overall, and were happy to have been part of the grant.

Staff members had numerous positive things to say about the quality of the Family Science program and the activities delivered by the Iridescent staff and engineering students. They thought the activities were effective in terms of the structure and design of the projects, and of the level of creativity involved. The program also aligned well with the mission and vision of both museums in making science engaging and fun.

Impacts

Overall, the collaboration was a good learning experience for the museums. One of the biggest impacts reported by museum staff was the fact that the program allowed them to engage, in a sustained way, with the local communities living in close proximity to the museums. In New York, Iridescent worked with staff in the museum's community engagement office as well as with school-based parent coordinators to recruit families for the Saturday workshops. This collaborative outreach approach helped the museum strengthen ties to the various communities and develop relationships with different audiences over the years. According to the Program Manager at NYSci, "[by] recruiting kids from neighboring schools and building ongoing relationships with the schools and families, we have been able to retain people from that audience. ... We have our programs where we try to engage our neighboring schools and community, so we will definitely continue to reach out because we want those students to come back and participate in some of our projects. ... We definitely want to continue to develop and maintain those relationships."

Partnering with the Family Science program meant that the museum also was able to increase its appeal and accessibility to local families. Families in the programs would often engage in the museum exhibits after the Family Science sessions ended. The Project Coordinator at NHM said, "The success, for the museum, is that it really did increase access. Families were able to come to the museum, and they had free admission and could stay and access the museum after the session." The museum staff at a echoed that sentiment: "Another benefit of the partnership is bringing more people in the community to the museum. The families who attend the sessions stay afterwards to check out our exhibits."

The Family Science sessions taught at the museums used an integrated approach to instruction, combining the creativity and engineering knowledge of the undergraduate engineering students with the content expertise of museum staff. Through these collaborations, the museums reflected on their own instructional approaches, and at times learned useful practices and methods. In New York, high school students involved in the museum's Explainer program provided support to the undergraduate engineers throughout the session. The Program Manager there described that collaboration as "successful" and added, "We do our programs in a different way, so Family Science has been a good learning experience for us around how to manage that kind of facilitation." In Los Angeles, the museum was both hosting the sessions and working to integrate the museum content into the learning. The Project Coordinator there described a moment when the educators succeeded at that integration. "We were finishing the class and we were outside in the garden, and we were using binoculars and watching birds fly,

and making wings; that was a really nice instance of pairing content and experience that was helpful for [the museum teaching staff].”

Challenges

The biggest challenge cited by the directors at both museums was the frequent staff turnover at Iridescent. The Project Coordinator in Los Angeles described her experience. “The staff turnover [at Iridescent] has been really challenging. I wasn’t sure I was going to be here all five years, who knows, but that has been a challenge and a hindrance to this process. I’m one of the people longest on the project now, having done this program for all five years. The Co-PI’s have stayed the same, but the project directors have not. They seem to be constantly trying to reinvent themselves, and we/I have stayed the same. It is hard to be a partner with an organization where your initiative may or may not still be relevant six months from now.” In New York, the Program Director described a similar challenge, but also described it as a learning experience. “It was challenging and frustrating in the beginning to work with Iridescent in coordinating the sessions due to short staffing and an employee leaving. The person who was in charge wasn’t responsive, and that created some difficulties. But the Regional Manager ultimately picked up where she left off, and things got much better. But I learned one of the ways to make that an easier transition is going with the flow; it’s important not to get bogged down in details of the past. Because these things happen, employee turnover is inevitable. So it’s really about finding ways to deal with it.”

Iridescent Staff Experience

The EDC evaluation team interviewed Iridescent staff from the Los Angeles offices. We asked staff to share information about their background and experiences running the Family Science program. In total, five staff members were interviewed in late March, and two were interviewed again in late April. Three of the staff members had been with Iridescent for the past two years, while two of the staff we spoke with had been part of the team just two months. Two of the staff we spoke with were men, and three were women.

Overall, staff members were enthusiastic about the Family Science program. They reported having very positive interactions with families and thought the program was strong and exactly what they thought it would be— a program to inspire young children and introduce science and engineering to underserved communities and families. Iridescent staff articulated what they felt was the essence of their work with the Family Science program. One longtime staff member talked about the value of seeing children’s faces when they complete a design challenge. “I think it’s very real-world-like, and I think most of us, we work in our office or with adults, but when you really see the fruit of what you’re working on is when you see those kids’ faces. I think it will be hard for me to work remotely and never see that, for example. And I think it makes you feel like what you’re doing is meaningful, like it impacts real people, and really I think Family Science shows that the most for us.” Another long-term staff member spoke about the importance of bringing families together to build a project. “I think, at the end of the day, the most valuable thing we provide is an opportunity for parents and families to build together. I think you don’t need presentations, you don’t need fancy anything. At the end of the day,

what we're giving them is the opportunity to build a project together—you keep that in mind, and then the rest of the things just become not the most necessary thing that you have to solve... .”

Impacts on Iridescent Staff

The experience of running the Family Science program was overwhelmingly positive. The staff really enjoyed training the EastT students, working with the families, and coordinating with school staff. Despite this being the fifth year of the program, the staff members continue to learn along the way. Staff members summarized some of the impact on themselves.

“It’s impacted me a lot in different ways—I guess personal, too; we’ve always talked about having a growth mindset and asking better questions and things like that. And then after always doing these presentations, ... I can put some of these things in practice at home.”—Longtime Iridescent staff member

“I think definitely this program has helped me become more persistent and be able to juggle multiple logistical problems at a time. Because there’re a lot of moving parts, and there’s always something with this program that comes up that you weren’t expecting.”—Longtime Iridescent staff member

“Prepare for the unexpected... mentally, prepare for the unexpected and a lot of logistical issues that you might need to account for and vary ... thinking on your feet, because a lot of these places, there is either a communication disconnect or something will inevitably go wrong, so you should always be able to be prepared with a plan B, essentially, or C.”—New Iridescent staff member

Challenges

Despite the overall success of the program, the staff mentioned some challenges and constraints that they faced in their work. One such challenge was the uncertainties that inevitably arise when running a five-week program that has many moving parts and a number of stakeholders involved. One staff member described her experience: “We try to anticipate as much as possible, but there’s always something that pops up almost every day. ... It’s definitely a program that has many moving parts and a lot of uncertainties. You don’t always know what the school’s going to have set up for you.”

Other challenges arose largely as a result of the difficulties involved with collaborations and partnerships, particularly with underserved, urban schools. One staff member described the challenge of working with the schools in Los Angeles. “I think that’s really where the failure and the success comes in, the buy-in from the administration and the teachers. ... [O]ne thing I don’t think we accounted for is how much administration change happens in an underserved community school. We literally have had schools that had three different principals in five years, or one of the magnet schools we worked with changed their school name twice. So they changed the entire focus of their magnet program. And those are not things that we could have

anticipated, necessarily. And I think that's a reality of schools in inner city, and not just a testament to the schools that we work with, but really to the system."

Despite being streamlined and fine-tuned over the years, recruitment continues to be an area of stress and uncertainty, even in the fifth year of the program. All participating schools are recruited via parents who have participated in previous programs or through building partnerships with local schools. To do this, program staff are responsible for finding the contacts at the schools and recruiting the parent volunteers or whoever is willing to work with them to implement the programs. One staff member described the challenge: "I think every year has been the same. At least for me, because I'm always worried whether I'm going to have people or not or if it's going to be very low attendance or not. So, to me, every year I'm always worried and I'm always trying to contact the school and be, like, 'Hey can you guys do this? Can you guys do that?'... The parents are volunteering to recruit families, and it gets a little bit harder when they're volunteers because we don't know when they have time to call families or send out flyers and things like that. And so we're always waiting till the last minute for the schools to get back to us, and they'll be, like, 'Oh, we have this many people.' "

Lessons learned

After completing five years of program implementation, returning staff have learned much about how best to recruit, implement, and manage the Family Science after-school program. They also learned how to better design, teach, and manage the Engineers as Teachers course.

Recruiting families has been a challenging process since the beginning of the program, but the Iridescent staff have learned tangible ways to tackle these recruitment challenges that include unpredictable scheduling demands of schools and variable buy-in of school administrators. In Los Angeles, for example, they tried various incentives (such as engineering books and T-shirts) to encourage families to attend every session. As mentioned before, Iridescent staff also trained parent leaders at the schools to take on the responsibility of recruiting families and making reminder phone calls—this eased the burden on staff and empowered parents to act as leaders while positively contributing to their child's education.

Changes in partnerships and recruitment were made at the New York site as well. Over the last few years (in response to a decrease in attendance), Iridescent was able to increase their participation rates by recruiting families from all of the schools that are in the neighborhood of the science museum, rather than just the two original partner schools. Moving the sign-up tool online made it easier for families to sign up for sessions and also for the schools to use digital communication tools instead of requiring physical flyers. Both of these changes allowed Iridescent to significantly increase the total number of participants served at this site, and also improved their relationship with the museum.

This year, Iridescent staff also were frank with schools about the degree to which their Family Science programs were in demand (they receive calls from six to eight schools a semester asking for the program) to provoke excitement and appreciation for the program and to

discourage complacency. One staff member described what Iridescent did differently this year: “One [area where] we need to do a better job is really sharing out with them what is the value that the families are having, like, they’re gaining from this experience. I don’t think, before, we did a very good job telling them that story. And we’re consciously doing more of that, too, with the schools, so they understand. Because not every principal or teacher comes to our programs all the time, they may not see the face of the kid who just built the paper rocket for the first time, but we’re trying to think about how to reinforce that.”

The partnership between schools and Iridescent staff also has improved for several reasons, including increased involvement of key stakeholders in setting goals and a clearer understanding of the respective roles and responsibilities in the implementation of programs. One staff member affirmed that the relationships have been on an improved trajectory since the program began. The staff has had some success at certain schools and has been able to motivate the teachers and administrators to lead a number of the sessions on their own. For example, schools are recruiting families, making the reminder calls, and ordering food for the sessions. Additionally, the principals and teachers are much more interested and excited about the program and the possibility of incorporating Family Science activities into their existing instruction and classroom work.

Finally, over the years, based on EDC’s annual feedback, Iridescent has modified the EasT curriculum to better support the engineering students. For example, initially it was assumed that the students would need the most support around the teaching aspect of the course. In fact, it was coming up with a good open-ended engineering design challenge that was most difficult. To address this, rapid prototyping and concept mapping was adapted into the curriculum to better support the engineering students in developing their design challenge. In another example, students expressed that it was difficult to connect with learning pedagogy, particularly through literature. As a result, Iridescent started incorporating more interactive ways to teach varied learning pedagogy through games such as “engineering charades” and by using inspirational education-oriented TED talks. Iridescent’s responsiveness to the needs of the undergraduate engineers not only made the course more effective and enjoyable for them, it improved the entire Family Science after-school program, making it more successful and fun for the families participating.

Recommendations

Iridescent staff had some ideas of how they would augment or improve the program if given the opportunity.

Maintain the ability to change school partnerships year-to-year. Staff members talked about the challenges of partnering with schools that were not fully committed to the Family Science program. They also noted that, year-to-year, they had many schools calling them and asking for the program. The staff would like to be able to change the location of the program to collaborate with schools that had the energy and motivation to be engaged and committed partners. One staff member described what the organization would do differently in the future.

“I think, actually, if we have the freedom to change the schools and go to schools where we’re appreciated, instead of the schools that don’t appreciate the value of what we bring. I think that makes it hard on everybody. It makes it hard to recruit and maintain the families, as well as even from the East students, it makes it hard for them to have a good experience when they go teach. [School staff will] say a volunteer will come, and then nobody comes to help and there’s a lot more burden on the students. I think it’s a limited resource that we offer, and I’d rather see it go more toward schools that really see the value in it.”

Develop more high-quality projects and content. One of Iridescent’s strengths is creating high-quality, age-appropriate, innovative projects and design challenges. Moving forward, the staff would like to continue to create and develop more engaging content for children, families, and other partners. One staff member succinctly explains: “The ability to come up with more projects—I think there’s a lot that that entails. I think to get really quality stuff, you have to reach out to different people and different scientists, different engineers, to get inspiration for that. And so I think that’s such a valuable part of this organization. I think we could benefit from doing more of that.”

Increase partner involvement. While the program is reaching a much larger population (they had more participants in attendance than anticipated in two schools during the 2015 session), there is still room for expansion. As a result, the staff would like to continue training teachers and other partners so they can continue implementing the program. They are actively reaching out to after-school programs and to local schools to establish ongoing professional development sessions for partners. The goal is to get more people engaged with the various projects that they offer, so they, in turn, will share that knowledge and get other people excited about and actively engaged in science and engineering. They have had some success at some schools and have been able to motivate the teachers and administrators to take on a leading role. For example, in Los Angeles, they have asked school principals to assign one administrator to attend sessions so that partners are engaged much more in the process and can learn the skills to implement the activities. The ultimate goal is to have more teachers and parents leading these sessions.

Provide more financial resources for schools. Because most of the schools they work with are vastly underfunded and under-resourced, there is a great interest among Iridescent staff in continuing to provide financial resources to the schools through micro-grants that will cover expenses for materials and other needs. Specifically, two different staff members described what that model could look like and how it could benefit the schools. “A lot of these schools don’t have the ability to provide materials, and I think that’s something really interesting and cool that we do. And I would really like to continue that, especially with some of our larger projects, like the BioBots⁴ and stuff. I think that’d be very neat, to provide some schools with those kinds of materials. I think that is very valuable.” A second staff member echoed those sentiments. “I think one of the best parts about [the Family Science] project actually is that we’re able to come to the school with all the materials, that [the schools] don’t have to

⁴ Biobots is a robotics curriculum developed by Iridescent staff.

purchase it. It would be nice to be able to do that, as we push schools to do more on their own.... Financials are always really hard in the schools that we have. So maybe making micro-grants to schools and making small grants to say, 'Hey with this \$1,000 you can do five sessions of Family Science on your own.' And empowering them that they can do that."

Improve technology tools to communicate with parents. Staff members would like to see improvements in the quality of the technology that Iridescent uses, specifically the key tag system for tracking attendance and the tools used to communicate and collaborate with families. In addition, they would like to hire more staff to support outreach efforts and to help alleviate logistical demands. They are excited about the possibilities of conducting a quasi-experimental study to measure the impact of the program on students' career goals post-high school, and understanding issues around participant retention and engagement. "That would also be something interesting to look at is our impact and their projected history, timeline—I don't know vocabulary for that, but whatever happens then after they leave high school. Do they have [interest in STEM in] college, or something like that?"

Summative Impacts

Over the last 5 years, Iridescent has reached 2,173 total unique participants. Stakeholders at all levels agree that the Family Science program has been a resounding success in its ability to repeatedly engage underserved urban families in science and engineering activities over many years. As an informal science education organization (ISE), Iridescent's Family Science program has directly addressed three major challenges commonly associated with ISE.

- They have created a scalable method of engaging minority audiences, including low-income children of color, English language learners, and girls.⁵
- They have identified sustainable methods to support long-term learning, including the Curiosity Machine website and school-based parent, teacher, and student learning communities. (For more details, see the *Future Directions* section on page 38 in this report.)
- They have enabled families to develop deeper content knowledge around topics related to science and engineering, as evidenced by participants' increased comfort level to do projects and talk about science and engineering at home.

⁵ Though not its focus, each year since 2011–2012, 54% of Family Science student participants, on average, were girls.

Iridescent also was successful in its ability to meet and exceed the goals targeted in its original National Science Foundation (NSF) proposal, which included engaging underserved families, increasing parent involvement in student learning, and providing social capital by way of access to engineering students.⁶ The multiple ways in which the organization was able to accomplish this are outlined below.

Engaging underserved families

Iridescent successfully recruited families with children attending Title I schools serving economically disadvantaged communities in downtown Los Angeles, California, and Queens, New York, and they were able to engage them over a sustained period of time. Seventy percent of the families directly participating in the program in 2015 indicated that they speak Spanish or a dialect of Chinese as the primary language at home. Appendix A shows the demographic data of the eight partner schools in Los Angeles and of the seven participating schools from New York. On average, across the schools in Los Angeles, 89% of the children participate in a free or reduced-priced lunch program, 88% are Latino, and 62% are English language learners or reclassified as fluent English proficient⁷. In New York, across the participating schools, 69% of the children participate in a free or reduced-priced lunch program, 49% are Hispanic, and 18% are English language learners.

In terms of fostering sustained engagement, over half of the families that participated in Family Science in the spring of 2015 were returning families. In fact, each year since 2012, on average, over half of the families were returning for a second or third time (54%). Though not without its own challenges, Iridescent's approach to work continuously with the same nine institutions (eight schools in Los Angeles and the NY Hall of Science in New York) over the entire five-year grant meant that interested students and families could return to the program year after year and continue to engage and improve their science and engineering skills.

Promoting total family engagement

Iridescent's approach to informal science education was innovative in many ways, but perhaps most notably because of its focus on including entire families in the learning process, from parents to grandparents to young siblings. Since the first year of the program, EDC has reported similar findings highlighting the fact that the program "brings the family closer together" (2012 evaluation report, page 16) and that parents "enjoy spending time as a family" (2011 evaluation report, page 11). Stakeholders at all levels agreed that working together to solve design

⁶ These goals are identified in the original proposal to the National Science Foundation, where Iridescent described the *Be A Scientist!* Program: "The goal is to create a scalable, technology-based, ISE infrastructure to engage underserved families with cutting-edge science, increase parental involvement, and ultimately increase the numbers of Hispanic and African-American children pursuing STEM studies."

⁷ "Reclassified as fluent English proficient" refers to students who have achieved proficiency on multiple standardized language tests, (including the California English Language Development Test, California Standard Test of English Language Arts, District writing assessment, and the English Language Development progress report) and receive parental approval. RFEF classification indicates both proficiency in the English language and participation equal to that of average native speakers in the school's regular instructional program.

challenges as a family was one of the most rewarding and successful aspects of the program. A 5th-grade girl from New York wrote, “It is AWESOME!!! I like it because it teaches us different vocabulary and I have fun with my family.” A mother from New York said, “I loved how the projects allowed my family to work as a team and provided us with an opportunity to do things we normally would not do.” Another mother from California shared similar sentiments: “We are together as a family, and I like being close to my son, learning together.”

The EasT engineering students also noticed changes in the families. One student remarked, “The growth in the families as they tinker is incredible for five sessions. I also love the positive feedback from the parents and kids. It is easy to see how much they are learning by the questions they ask you throughout the five weeks. I also love how much fun the kids are having and how excited they are to come back each week.”

School-level personnel who were involved with the program agreed, as well. Administrators described families as “engaged and excited to come to the school to participate in learning with their children.” A 5th-grade teacher talked about the benefits for parents as well as students. “A hands-on experience working with your child is magic, parents are participating in a productive way, it is not just a learning experience for kids, but also for parents, it’s all of us working together.” Another 5th-grade teacher said that she would often recommend the Family Science after-school program to parents who asked what they could do to help their kids in school.

Promoting dialogue with trained scientists and engineers

Iridescent’s Family Science program set out to expose urban youth to college-educated scientists and engineers, to whom they might not otherwise have access. The teachers and administrators we spoke with indicated that a key benefit of the program is that children and their parents have the opportunity to see and talk with college students who are also engineers or scientists, and that they can see how doing the Family Science activities is both fun and also real science. One principal noted that, for some families, this might be the only regular interaction they have with a scientist. One mother from New York agreed. “I loved how the instructors broke down scientific concepts that were easily understandable. The instructors are great role models.” One of the EasT instructors noted the value of his experience working with families. “I think it is a wonderful experience that provides exposure and understanding to underprivileged communities, while at the same time learning how to effectively inspire/encourage/challenge/excite children about the opportunities available in higher levels of education.” Iridescent was able to accomplish this in part by developing a high-quality, in-depth, semester-long course to train the engineering students on how to develop open-ended engineering design challenges and how to teach entire families.

The Family Science program also had impacts on additional dimensions that were not directly targeted by the organization, including fostering scientific thinking skills, inspiring children toward STEM careers, increasing the number of STEM-related activities students and parents engage in at home, and improving engineers’ communication skills. Previous evaluation reports

reveal similar impacts, which highlight Iridescent’s unwavering quality over the five years, despite changes in staff and partners and tweaks to the program offerings.

Table 6, below, shows, year by year, the percentages, when available, of students who agreed or strongly agreed with various statements after completing the Family Science program.

Table 6: Self-reported Impacts on Students Over Time

Impacts	Percentage of students who agree or strongly agree with each statement				
	2010–2011 School Year*	2011–2012 School Year	2012–2013 School Year	2013–2014 School Year	2014–2015 School Year
I am more interested in science at school.	N/A	75%	82%	92%	86%
I am more likely to keep trying if I don’t figure something out after the first attempt.	N/A	N/A	89%	90%	89%
I do more science-related activities with my family.	N/A	65%	Data not available	76%	72%
I am more excited about doing challenging activities.	N/A	74%	88%	97%	94%
I understand science and engineering better.	N/A	75%	83%	85%	90%

*Data is not available due to inconsistent responses from participants and to other factors impacting data collection.

The table reveals both a consistently high level of self-reported positive impacts and an increase of positive impacts over time. Over 65% of students report agreeing or strongly agreeing with every statement for every year that data was collected. Additionally, students’ average level of agreement across the items increased from year to year with the exception of the 2014-2015 school year. Students’ responses were particularly positive in the 2013-2014 school year so there is a slight decrease in levels of agreements from the 2013-2014 to 2014-2015 school years. But, overall, from 2011 to 2015, that data show that student agreement levels have been on an upward trajectory.

Self-reported impacts for parents were similarly positive and consistent. Table 7, below, shows, year by year, the percentage of parents who agreed or strongly agreed with various statements after completing the Family Science program.

Table 7: Self-reported Impacts on Parents Over Time

Impacts	Percentage of parents who agree or strongly agree with each statement				
	2010–2011 School Year*	2011–2012 School Year	2012–2013 School Year	2013–2014 School Year	2014–2015 School Year
I will encourage my child(ren) to pursue an education or career in science or engineering.	70%	78%	80%	86%	91%
I am more confident talking about science/engineering topics with others.	N/A	67%	80%	85%	78%
I will read more science books with my children.	N/A	89%	90%	93%	92%
I believe that my child could someday have a career in science or engineering.	N/A	Data not available	73%	79%	88%
I will do more hands-on activities with my child(ren)	N/A	Data not available	90%	96%	94%
I understand science/engineering better.	N/A	78%	82%	81%	92%

*Data is not available due to inconsistent responses from participants and to other factors impacting data collection.

The table reveals both a consistently high level of self-reported positive impacts and an overall increase of positive impacts over time. Over 67% of respondents reported agreeing or strongly agreeing with every statement for every year that data was collected. Additionally, parents’ average level of agreement across the items increased from year to year with a few exceptions in the 2013-2014 and 2014-2015 school years when the level of agreement dropped a few percentage points on certain items. But, overall, from 2011 to 2015, that data show that parent agreement levels have been on an upward trajectory.

Fostering scientific thinking skills

Stakeholders at all levels commented on changes in students’ ability and willingness to engage in scientific thinking skills such as perseverance, patience, and creativity. Similar findings were reported in our 2013 and 2014 reports. These reports described the children as being “more persistent problem-solvers,” as asking more questions, and as being less afraid of being wrong. The 2015 data suggests that the program influenced parents’ ability to think like scientists as well. A large majority of students agreed that since participating in the 2015 Family Science program, they were more likely to keep trying if they didn’t figure something out after the first attempt (89%). This finding was also consistent with past survey data, with nearly identical percentages of children agreeing with this statement in 2013 and 2014.

Program participants this year shared some concrete examples of increased student perseverance. One teacher stated that he could see that the kinds of activities the Family

Science program introduced helped with things like problem solving and persistence and that he had begun to integrate some elements of the Family Science program into his own teaching. One longtime parent described the changes she has observed in her daughter: “At the beginning [my daughter] did have trouble with school and she would kind of get frustrated and saddened, but after joining the [Family Science] classes ... she noticed that it was okay. When she was able to see by herself that it’s okay to mess up, it did help her understand that sometimes not everyone is good at school, but as long as you keep pushing yourself... [Family Science] helps them a lot in the fact that they learn how to fail. Like the fact that sometimes their projects don’t work at the first try, and they learn that it’s okay to mess up and they could go ahead and retry the same thing.” In fact, survey responses indicate that, on average, across the past four years of Family Science, 88% of students agree that after participating in Family Science they were more excited about doing challenging activities. Another parent mentioned that she has noticed that her sons “are more comfortable talking and engaging with science projects. They are definitely thinking outside the box and really expanding their thinking/mind.” A mother echoed similar sentiments about her son’s ways of thinking. “My son works more independently and analyzes things on his own. I have noticed that he has more ideas and things to say in general during the sessions.”

Parents and Iridescent staff also noted changes in *parents’* scientific thinking and behavior since participating in the program, including asking different types of questions and being more creative and persistent. Similar changes were reported in EDC’s 2011 evaluation report. Nearly all of participating parents in 2015 agreed that, since partaking in the Family Science program, they would ask their children more questions about their science class (94%). An Iridescent staff member who is also a parent of children in the program talked about how the types of questions he asks his children have changed. “[At Iridescent] we’ve always talked about having a growth mindset and asking better questions. ... For example, like at home when they go and ask my wife for help, she’s always trying to give them the answers or showing them how to do the work. But when I go and they ask me, I’m like, ‘Okay, well, what is it asking you? What is your homework telling you to do?’ And I have them read back the question or read back whatever passages they’re trying to solve, and then they figure out what they have to do. And it’s making me a little more patient.” The Iridescent staff members described changes in parents’ skills as scientific thinkers. “A lot of veteran moms just sit back and they just ask questions and instead of, like, keep chiming in. So this is what the kids build, which I think is an important aspect. So a lot of time parents are afraid of watching their kids fail and want to do it for the kids, but you see in families that are veteran parents they just ask questions, ‘Abigail, why do you think that is?’ ‘Martha, how do you think this will work?’ So they ask that question, you see them mirroring the good questions to have them encourage those mindsets.”

Other staff members talked about persistence and innovation among veteran parents who encourage their children to try new designs, even if they already completed the design challenge. “The veteran parents always seem to be more comfortable staying throughout the whole session. While the new parents are a little bit more impatient and want the show to get going. And I have noticed some parents that once they do one project, you know, it’s their first

time, they're very ... they're ready to leave. That's done. A veteran parent is much more likely from my experience to stick around to redesign and to really ... to go back to the drawing board and improve their design."

Inspiring students toward STEM careers

As indicated in Figure 2 on page 11, students who participated in the Family Science program agreed that they had a better understanding of the jobs in science and engineering (88%), and long-term participants indicated that the Family Science program had influenced them to consider pursuing careers in these fields. As described in the Findings section, 85% of students agreed or somewhat agreed that they would be a good scientist or engineer someday. Nearly the same percentage of parents agreed that their child could someday have a career in science or engineering (86%). One mother stated that her youngest daughter wants to be an engineer, and she credits the program for opening her eyes to that profession. Even more pointedly, all eight of the long-term participant students interviewed said they were interested in pursuing a career in a STEM-related field. The majority of them attributed their experience at Family Science as having a major influence on these aspirations. One older girl who was a junior in high school talked about how Family Science has influenced what she wants to study. "Before now, I wasn't sure about what I wanted to major in in college, but I did know I wanted to go to college. But now I'm actually thinking of pursuing a biomedical engineering career. ... We did some life science [design challenges] and we did a lot of building and basic engineering thought processes [in Family Science] that helped me decide." Similar findings were reported in our 2012 report highlighting the power of the program to influence and inspire children toward careers in STEM fields. On average, across the past four years of the program, 81% of students agree that they would be a good scientist or engineer.

Parents also indicated that they have a better understanding of jobs in science and engineering (83%), and the majority of them thought highly of STEM-related careers, suggesting that parents are better positioned to support their children in pursuing careers in these fields if that is what they choose. In fact, 91% of parents said they would encourage their child to pursue an education or career in science or engineering. In previous years, on average, three-quarters of parents agreed with the statement (76%).

Increasing STEM activities at home

Despite being a five-week, after-school program, participant responses suggest that Family Science has had impacts on what families do offsite and out of school. On surveys and in interviews, parents and students talk about the ways in which they are doing more science- and engineering-related activities at home as a result of participating in the Family Science program. While 72% of children report doing more science-related activities with their families, parents indicate they will take their children to more zoos, science museums, and nature centers (96%), that they will do more hands-on activities (94%), that they will watch more science-related TV shows (93%), and that they will read more science-related books (93%). One mother of a child at Quincy Jones Elementary School, and long-term participant, talked about her daughter building more at home. "She likes to build a lot more stuff, stuff she finds around the house,

because now she knows that she can use anything, so she kind of, like, whatever we have at home that becomes trash for her, it's like an excuse for her to build something. And she always tries to find a way how to fix stuff because of what she learned." EDC reported similar findings in our 2014 report, when parents reported that their children were more likely to talk about science and to do science activities at home.

Improving undergraduate engineers' communication skills

Year after year, the undergraduate EasT students describe how their ability to accurately and appropriately explain complex topics to a large non-engineering audience improves over the course of their semester teaching Family Science. During the 2015 program, one EasT senior in Electronic Engineering Technology reported, "I have gained more confidence in public speaking, this program helps you to articulate what you want to say, in a fashion that kids and the audience understand." EDC researchers observed similar growth. In EDC's 2011 report, we wrote that EasT students "developed better communication skills in sharing complex scientific content." In our 2013 report, we stated, "EasT students improved their communication and collaboration skills ... and learned how to work with diverse audiences, including young children." One of the museum staff partners pointed to the improvement of the learning tool portfolio as a catalyst for improved communication skills. "I think the portfolio got more effective and gave the students a sense of the engineering design process. I think that [the engineering process] was communicated more and more effectively over the years." For returning EasT students, these improvements were compounded. An Iridescent staff member said that he could see a difference in how returning engineering students communicated with families, compared to first-time EasT students. "[The returning EasT student] is definitely very willing to go through the engineering design process and is much more open to that than a lot of kids coming in. I guess it may be an obvious observation, but she's more comfortable with the process. You can see that through the way that she speaks with the kids as well, and through the way that her presentations are structured."

Future Direction

In anticipation of the final year of the Family Science program, and in direct response to interest from parents, Iridescent has been working hard to develop an alternative method for delivering high-quality, hands-on science- and engineering-focused educational activities to youth. With funding from a *Transforming STEM Learning* (TSL) grant from the National Science Foundation, they have built an online learning portal called *Curiosity Machine* (www.curiositymachine.org/) to support children, teachers, and families in doing science and engineering projects at school and at home.

The organization has been working on the *Curiosity Machine* site since 2012, and although the Family Science program cannot be entirely replicated in an online environment, certain aspects of the program are being adapted for K-12 students who have access to a tablet or computer and reliable Internet at home. *Curiosity Machine* provides families and schools access to Iridescent's design challenges and videos with real engineers and scientists communicating

their work strategies. These professionals are also available to provide online mentoring and support to students as needed. A key component of the platform interface is a guide through the engineering design process, where children can document their building steps at each stage and continuously iterate on their inventions. This supports the development of the key character traits of creativity and persistence. The website also provides training and resources for parents and educators to learn the basics of physics concepts and techniques to nurture children's growth mindset and innovative thinking.

Since 2014, parent participants in the Family Science programs have received information about the *Curiosity Machine* website. To further familiarize parents, some of the online design challenges were used during the Family Science programs in 2015. Iridescent staff also introduced the online interface to entice parents to use it during their summer break to support their child's science learning.

The organization's long-term goal has always been to build learning communities within the schools that can be sustained even without direct intervention from Iridescent. Moving forward, Iridescent will build out the support structures that underserved communities with limited access to hardware and reliable Internet will need. The intent is to continue to improve the functionality of the website and to help students continue their learning after attending an initial in-person program. *Curiosity Machine* is Iridescent's way of ensuring that underserved urban youth continue to have access to inspirational scientists and engineers and that they continue to learn about and practice the engineering design process, even when the Family Science program is no longer running.

Conclusion

The Be A Scientist Family Science program achieved the three goals identified in the program's initial proposal:

- engaging underserved families living in low-income communities;
- increasing parent involvement in student learning; and
- providing social capital by way of access to engineering students.

However, the program also achieved multiple additional goals that contributed to the overall positive impact of the experience on its participants. These included:

- promoting dialogue between scientists and engineers and families and children;
- engaging school staff in STEM activities and encouraging transfer of STEM content to classrooms;
- fostering scientific thinking skills;
- inspiring students toward STEM careers;
- increasing STEM activities at home;
- bringing engineering students into contact with communities and experiences not typically part of an engineering program; and
- improving undergraduate engineers' communication skills.

The program brought families—mostly Spanish-speaking—from under-resourced communities into communication with young science professionals in ways that allowed parents and children to engage with new ideas and materials, learn about different STEM concepts, and see a college-aged student working toward a degree in a STEM field. The program engaged children and their parents in STEM experiences that were hands-on, age-appropriate, content-rich, and guided by young and knowledgeable adults (East Students), who modeled ways of engaging with science in an informal manner while still targeting key concepts. These experiences took place in school settings—environments where parents are rarely involved in their children’s learning—and were open to entire families, including younger and older siblings and extended family members. All of these aspects combined to create a strong and lasting impact on the children, families, and engineering students involved.

The challenge this program faces is one that so many effective education programs encounter: It is highly effective in meeting its goals, is embraced by the families, students, engineering students, and school staff who are its target audience, but it is difficult to support without ongoing access to the resources needed to secure and manage partnerships from engineering programs and local schools. While the *Curiosity Machine* portal is highly functional and is equipped to support the Family Science program, families and children may not be ready to move to a Web environment. Both program and school staff indicated informally that many families have Internet access, but often the access is via a smart phone or a slow connection that interferes with the ability to access the Iridescent website. A key challenge staff have encountered is the fact that not all aspects of the program can be translated into the online environment; however, staff are continuing to work on this issue. The program is also experimenting with alternate approaches through partnerships with corporations and through work with mentors who work in STEM fields.

The Family Science program provides something that is often absent in the lives of young children who live in communities that are at the lower end of the economic spectrum: access to a wide range of adult professionals working in the fields of science, engineering, and math. This limited contact with adults who are pursuing professional STEM careers can have a substantial impact on young children’s lives and choices that is long lasting. This is well documented by the sociologist Robert Putnam in his recent examination of the growing divide between opportunities for children of lower- and higher-income families and communities (2014)⁸. Be A Scientist helps to make a difference in the lives of children and families who do not have access to adults working in STEM fields, and for the children and their families who participated during the project’s five years, this difference was noted by all participants.

⁸ Putnam, R. (2014). *Our Kids: The American Dream in Crisis*. New York, NY: Simon & Schuster.

Appendix A

Participating Family Science Schools in Los Angeles

Student Demographics	Western Avenue	Frank Del Olmo	Synergy Charter	Betty Plasencia	Quincy Jones	Vermont Avenue	32nd Street	Norwood Street	Average
Number of students enrolled	510	786	312	708	367	754	1,099	652	649
Students participating in a free or reduced-price lunch program	81%	89%	87%	89%	98%	87%	87%	92%	89%
English learners	45%	62%	50%	38%	66%	54%	12%	46%	47%
Reclassified fluent English proficient	8%	15%	17%	10%	13%	14%	28%	11%	15%
African American	25%	1%	3%	2%	2%	10%	16%	3%	8%
American Indian	0%	0%	0%	0%	0%	0%	1%	0%	0%
Asian American	0%	8%	0%	3%	0%	0%	5%	0%	2%
Filipino	0%	1%	0%	2%	0%	0%	1%	0%	1%
Latino	74%	89%	96%	90%	98%	88%	72%	96%	88%
White	0%	1%	1%	3%	0%	1%	6%	0%	2%

Source: Los Angeles Unified School District, 2013–2014

Participating Family Science Schools in New York City

Student Demographics	P.S. 16Q	P.S. 139Q	NEST+m	P.S./I.S. 119Q	P.S./I.S. 217	P.S./I.S. 5	P.S. 330Q	Average
Number of students enrolled	1716	847	1735	1090	536	799	572	1042
Students participating in a free or reduced-price lunch program	100%	67%	27%	68%	35%	89%	96%	69%
English learners	44%	18%	0%	4%	8%	22%	30%	18%
Black	0%	3%	9%	2%	19%	23%	2%	8%
Asian American	9%	25%	33%	23%	28%	0%	9%	18%
Hispanic	90%	34%	11%	32%	16%	74%	87%	49%
White	0%	36%	42%	43%	34%	2%	1%	23%

Source: The Center for New York City Affairs/Inside Schools