Engineering students teaching hands on engineering design challenges to underserved community families

Dr. Amy Hee Kim, Iridescent

Amy Kim is the Sr. Director of Content Development at Iridescent, a science and engineering education nonprofit. She is trained in physical chemistry (Ph.D. University of Chicago) with a strong passion for improving STEM education in informal settings. In graduate school, she chose to pursue a career path where scientists can give back to their communities. She was a science policy fellow at the National Academy of Sciences where she learned how to effectively communicate science. She believes that the critical thinking skills acquired through STEM education are essential, and wants to inspire the next generation to always query the unknown. Amy is passionate about connecting scientists and engineers with students who might not otherwise have the opportunity to connect one-on-one with STEM professionals.

Ms. Tara Chklovski, Iridescent

Ms. Chklovski is the Founder and CEO of Iridescent, a science, engineering and technology education nonprofit. Before starting Iridescent, she worked as the principal at a 300 student K-6 school in India. She has founded and grown Iridescent from a one-woman effort to an organization reaching 30,000 underserved students globally. With the help of a passionate team of 21 people, she has consistently and cost-effectively doubled Iridescent's impact every year by relying on technology, synergistic partnerships, rigorous evaluation and volunteers. One of Iridescent's programs, is now the world's largest program teaching girls to become technology entrepreneurs, with a presence in 45 countries. She has a B.Sc in Physics and a M.S in Aerospace from Boston University.

Engineering students teaching hands on engineering design challenges to underserved community families

Engineering students teaching hands on engineering design challenges to underserved community families

ABSTRACT

This paper discusses the implementation of a 5-year longitudinal study called "Be A Scientist!" (BAS). This project has been funded through an NSF AISL grant with the title "Be a Scientist!"(BAS). BAS is designed to connect underserved families directly to scientists and engineers with the aim of inspiring families to see themselves as innovators and inventors, while also encouraging the development of key 21st century skills (curiosity, creativity, and persistence). BAS uses a "train-the-trainer" model, where engineering students are trained to develop and teach hands-on projects to local students and their families over the course of a 5-week Family Science Course held at a local school. This model consists of 5 steps:

- Engineering students are trained to develop (hands on) open-ended engineering design challenges that are inspired by and illustrate a key concept from their own work/current research.
- Engineering students test out their designs with local families during Family Science course
- The best designs are published on an online engineering curriculum platform (which is funded by another NSF-AISL grant)
- We then train local teachers, after-school educators and parents to use this curriculum to engage more families
- Trained engineering students continue to mentor families online

Over the past eight years--four spent running BAS--we have trained 2500 engineers and scientists to engage 28,000 children and parents nationwide. BAS is externally evaluated each year by the EDC Center for Children and Technology. Annual evaluations have found that children develop positive attitudes towards STEM activities (including hands-on building), become more persistent in solving design challenges, and believe that they can go on to be good scientists and/or engineers. Parents have also developed positive attitudes towards STEM programs as well as positive perceptions of STEM jobs and careers, and their STEM-related child-rearing practices improved (including at-home exploration and experimentation, the quality of questions asked at home, and building together). Evaluations also indicate that Engineering students benefit by learning how to create lesson plans as well as engineering design challenges, sharpen their own understanding of engineering concepts in the process of breaking them down to explain to a non-professional or academic audience, and that they enjoy contributing to the local community and working in-person with students. Engineering students often express a sense of re-igniting the passion that led them to pursue a STEM degree in the first place and benefit from working directly with students in their community.

2015 marks the final year of Iridescent's "Be A Scientist!" (BAS) project, a five-year longitudinal study sponsored by the National Science Foundation (NSF). Through BAS, undergraduate engineering students are trained to design and teach hands-on engineering design challenges during Family Science Courses to underrepresented students and their families in local elementary schools. The project's goal is to provide quality science and engineering courses to families in New York City and Los Angeles, and to retain the same families over five years. The project is also intended to identify a scalable model for the program.

Iridescent's Educational Model

The BAS model is shaped by (and in turn has influenced) Iridescent's educational model. Iridescent's programs aim to develop key life traits of curiosity, creativity, and persistence while increasing STEM conceptual and content knowledge. A challenge has been to provide enough opportunities to students to practice and hone problem solving skills -- as with music or sports, it takes thousands of hours of practice to be able to solve complex problems and innovate. Iridescent's solution has been to identify non-financial resources (i.e. social capital in the form of engineers and parents) and to use technology to provide opportunities for practice. Building on these tenets, Iridescent's model has the following stages:

1. ***Train*** *engineering communicators* - Train engineers to communicate technical subjects in a culturally sensitive and engaging way to underprivileged communities. Also teach parents the value of science and engineering education and how to facilitate a child's STEM exploration at home.
2. ***Model*** *the engineering design process for families* - Engineers lead 5 week Family Science Courses where students and their families are introduced to Open-Ended Engineering Design Challenges and the Engineering Design Process.
3. *Provide* **guided group** *practice* - Families come together in Curiosity Courses at the school to continue practice with Open-Ended Engineering Design Challenges, aided by curriculum on Iridescent's online platform Curiosity Machine, and by virtual mentors. These courses are different from Family Science Courses as there are no engineers present to lead the instruction. Content is provided through Curiosity Machine videos that profile engineers and scientists talking about their work. However, the same engineers that taught the families during Family Science Courses can continue to provide feedback to the same families, as virtual mentors through the Curiosity Machine platform.
4. *Continue* ***individual*** *practice at home, over time* - Families continue learning and being mentored at home through Curiosity Machine. The key difference from Curiosity Courses is that families are learning on their own, without the larger group of families

Fig. 1 - Incentives for Engineers and Parents to work together in Family Science Courses

The BAS project has covered the first two stages of this model, and in our final years we are laying the groundwork for stages 3 and 4.

Implementation

BAS is implemented in communities in South Central Los Angeles, and Queens, New York. Partner schools were selected based on demographics (high percentage of underrepresented minority children) and percentage of children qualifying for federal free or reduced lunch. Partner schools include Synergy Charter, Quincy Jones, Betty Plasencia, Western, Vermont, 32nd St, Frank Del Olmo (LA). Initially, the BAS project targeted families with children who would be enrolled in first grade in year one and end at fifth grade in year five, but in an effort to better serve the schools, the project reach was expanded to engage students in other grade levels as well.

Other partners include universities in Los Angeles and New York, namely University of Southern California and Cooper Union, as well as the film department at USC (to visually capture the impact of Family Science on families over the five-year study). Additionally, the Natural History Museum in Los Angeles (NHM) and the New York Hall of Science (NYSCI) are out-of-school-time partners and have been active in developing curriculum and hosting programs at their sites.

Communication Training

Through BAS, engineering students learn to communicate physics and engineering concepts to the public, and to develop hands on engineering design challenges related to the concepts. The engineering students then teach Family Science Courses at a local elementary school to children and their families. The engineering students participate in an accredited “Engineers as Teachers” course through their universities.

Engineers as Teachers (EasT) is an engineering communications course offered to undergraduate students at University of Southern California and Cooper Union. The course aligns with the Accreditation Board of Engineering & Technology (ABET) requirements. Engineering students receive technical engineering credits (3 units). Through the course, EasT students learn how to effectively communicate complex physics and engineering concepts with local families from underserved communities who have had limited previous exposure to such topics.

The course is structured around the EasT students developing a hands-on engineering design challenge that illustrates a concept from their own research or engineering fields, and then teaching these design challenges at a Family Science course. These design challenges must ask families to work through the engineering design process as they build together, must use simple materials, and must feature “low walls, and high ceilings”--being clear enough for less familiar students or family members to begin building comfortably, while also complex and rich enough for students to iterate on. Through developing these design challenges and disseminating them, EasT students learn how to rapidly prototype an idea, how to turn the complexities of their daily work into an engaging hands-on design challenge that is open-ended and appropriate for a wide range of students, and how to effectively communicate the physics and engineering concepts behind the challenge. Because the schools and families EasT students work with come from underserved areas, the course also provides training on cultural sensitivity as well as educational pedagogy.

A successful open-ended engineering design challenge (OEEDC) must have a clear purpose and goal with an explicit way to measure success, must be explanatory to help children understand the main concepts being conveyed, and encourage exploration by allowing for multiple viable solutions to the design prompts. It should also have a tangible outcome and an engaging test to demonstrate success of the design, be exciting by having a real-world application and encourage families to explore further, and it should be creative and original, offering an unforgettable learning experience for the families.

Each year about 25-35 engineering students participate in the Engineers as Teacher course. These EasT students teach Family Science Courses at local schools or educational institutions (such as museums). In years one through four, BAS has served 2088 participants in total, 39 of whom have returned for all four years, and 220 of whom have participated for two out of four years. Most families reached through these Family Science Courses are from underserved communities with children attending Title I schools. In addition, the majority of the parents of the students we serve through Family Science are English learners.

The BAS program model overcomes language barriers by providing bilingual materials, on-site translators, and by communicating with adults through bilingual children. The direct instruction piece during which the engineering students introduce and explain the concepts is limited to 15 minutes, to ensure the translation process is not tedious for English speaking adults. We also encourage our engineering students to incorporate kinesthetic learning tools that do not require understanding of the language which helps in young students understand key concepts.

Modeling the Engineering Design Process

Family Science Courses consist of 5 sessions, each of which is 2 hours long, and held during evening hours to accommodate parents' work schedules. Other accommodations include having schools provide dinner, providing bilingual materials and having translators translate presentations and instructions, and making sure that all families are welcomed, from younger siblings to grandparents. The BAS program materials are designed to enable parents to develop their own skills while facilitating their child's learning, allowing them to actively participate regardless of their own education and familiarity with the concepts at hand.

Each session is structured around a different engineering design challenge that allows parents to work with their children and practice using the engineering design process through a hands-on activity. Family Science aims to foster participant's intrinsic motivation and self-direction so they become lifelong explorers. Because participants' prior knowledge of the problem at hand is often limited, engineers first introduce the core concepts in a 15 minute presentation. After this instruction, families have the freedom to evaluate and shape their learning, pursuing those questions and concepts that are of greatest interest. Additionally, by moving through the stages of inspiration, planning, building, reflecting, and redesigning (i.e. engineering design process (EDP)) with their children, parents and caregivers model important skills -- including persistence, creativity, and curiosity to find new solutions.

Evaluation

Iridescent has been running the BAS program for 4 full years as of January 2015, partnering with the EDC Center for Children and Technology for annual external evaluations of the program. Because the program is entering its 5th and final year, we cannot yet make claims about program impact overall, but we will review our annual program evaluations here.

Learning Goals

BAS's learning goals are aligned with Iridescent's mission -- to create and deliver powerful science, engineering and technology education to help underprivileged young people develop curiosity, creativity and persistence. Through the hands-on, open-ended engineering design challenges students are asked to build, we expect them to acquire an understanding of the concepts at work, but we also look for development of traits and life skills, focusing more on the development of these 21st century skills rather than focusing solely on specific content knowledge (Fig. 2).

<table>
<tr><th></th><th colspan="3">Traits</th><th colspan="2">Life Skills</th><th colspan="2">Domain Knowledge</th></tr>
<tr><td>Student Outcomes</td><td>Curiosity</td><td>Creativity</td><td>Persistence</td><td>EDP</td><td>Problem Solving</td><td>Content</td><td>Conceptual Understanding</td></tr>
<tr><td rowspan="3">Evidence</td><td>Increased STEM interest</td><td>Using unique materials</td><td colspan="2">Iterating</td><td>Completing OEEDC</td><td>Recall facts and terms</td><td>Know how complex systems work</td></tr>
<tr><td>Pursue STEM careers</td><td>Making novel designs</td><td>Discussing Failure</td><td>Performing all steps of EDP</td><td>Discussing Failure</td><td colspan="2">Describing how systems work</td></tr>
<tr><td colspan="7">Experimenting</td></tr>
<tr><td rowspan="3">Assessment Method/ Student Task</td><td>Pre-/Post-Surveys</td><td rowspan="2">Student Portfolios</td><td colspan="5">Student Reflections</td></tr>
<tr><td>Post follow-up</td><td colspan="5">Building Methods</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Student Portfolios</td><td>Pre-/Post -Surveys</td><td></td></tr>
</table>

Fig. 2 - Iridescent program's learning goals and assessment methods

The Engineering Design Process is at the center of BAS and all Iridescent programs -- given its emphasis on reflection and redesign, the EDP provides key opportunities for students to develop their problem solving skills and critical thinking skills.

Working in the informal educational space, and with the entire family unit, Iridescent is able to provide a safe space to fail, and opportunities to learn from those failures. Rather than associating failure with a bad grade or similarly permanent repercussion, with the EDP, failure is presented as inevitable and integral to the design process. Students are encouraged to reflect on and learn from these failures to develop a more successful design. This lowers the stakes of failure, which encourages students to develop the courage to fail, and to try more creative solutions. Carol Dweck's work on Fixed and Growth mindsets emphasizes the value of being able to persist through failure and see failure as a learning opportunity -- we have found that the EDP is a useful tool for illustrating the value of failure and fostering the development of growth mindsets [1]. By using the Engineering Design Process to scaffold learning, our programs emphasize the importance of persisting through setbacks, along with the importance of thinking creatively about solutions to the problems raised by those setbacks.

Such traits are beneficial to academic performance in the short term, but the benefits carry over much further, into adulthood and the workplace. Especially given the effects of globalization and technological development in the professional world, traits like curiosity, creativity, and persistence are becoming key predictors of job performance -- more so than academic performance alone. Employees with high levels of curiosity and persistence learn more new skills, master new challenges, better handle unfamiliar situations, and can adapt more efficiently to changes to core tasks, teams, and the organization itself [34-36].

For the duration of BAS, Iridescent has partnered with the EDC Center for Children and Technology for annual external program evaluations which identified the following learning gains for participating engineers, engineering students, children, and their parents:

	LEARNING & ACHIEVEMENT	**INTEREST & IDENTITY**
Engineering Students	PROBLEM SOLVING: Learned how to create successful, open-ended projects.	Enjoyed going to school sites and creating prototypes.
	TECHNICAL COMMUNICATION: Learned how to simplify their language, break down complex science content into simpler concepts and present them clearly. 86% were more proficient teaching complex science ideas to a non-scientist audience	SELF-EFFICACY: 90% felt proficient working with children
	LEADERSHIP: Learned to be assertive and how to make decisions	The families' excitement and fascination reminded engineers of why they became engineers and of fundamental enjoyment of creating things and taking them apart.
	PRODUCTIVITY: Learned to manage time better and collaborate	Enjoyed contributing to the local community.
	TECHNICAL UNDERSTANDING: Deepened their understanding of scientific and key engineering concepts.	IDENTITY: Realized that they can be both teachers and engineers.
	CREATIVITY: Learned that there is rarely just one right answer to a problem.	
Parents	STEM KNOWLEDGE: 82% understood science/ engineering better. 78% were better able to explain how things worked to their children & family members.	Enjoyed the Engineering Design Process (EDP) - designing, testing, and redesigning their models.

	STEM INTEREST: 80% were more interested in science and engineering	Enjoyed spending time as a family focused on the children, learning science.
	STEM CAREERS: 68% had a positive perception of STEM careers. 71% had a better understanding of STEM jobs. 80% planned to encourage their children to pursue a STEM education or career.	Enjoyed interacting with diverse families.
	PARENTAL INVOLVEMENT: They learned to do science experiments in fun and engaging ways. 90% of families talked about more science, watched more science shows and read more science books at home. 65% did more science-activities at home such as building things, playing with science kits and going to museums and zoos.	GROWTH MINDSET: Realized that how easy it is to make science experiments using everyday objects and materials.
	PARENTAL PRACTICE: 91% said that it improved their STEM child-rearing practices.	SELF-EFFICACY: Became more confident because their children saw them as people who knew things, who could build things, and solve problems.
Students	CONTENT KNOWLEDGE: Students learned new vocabulary & concepts and retained their learning after the program. 85% had a better understanding of science and engineering.	STEM INTEREST: 92% of students were more interested in science at school. 97% were more excited about doing challenging activities. 87% were more interested in building things, science programs, and exploring new things.
	CREATIVITY: Students started to think outside the box. They became more adept at inventing their own designs.	IDENTITY: Began to own their science and engineering learning through the inquiry process.
	PERSISTENCE: 87% were more likely to keep trying if they didn't figure something out at first. 89% became more persistent in solving design challenges.	SELF-EFFICACY: They gained confidence in their scientific knowledge and ability. They felt empowered to share what they knew with others. They believed that they could become scientists or engineers.
	CURIOSITY: Students wanted to build, invent things, experiment and make more things at home. They were eager to seek out more information about scientific topics on the internet.	
	STEM PRACTICE: 65% of students did more science activities with their families.	

Table 1 - BAS Learning Gains, as evaluated by the EDC

Students

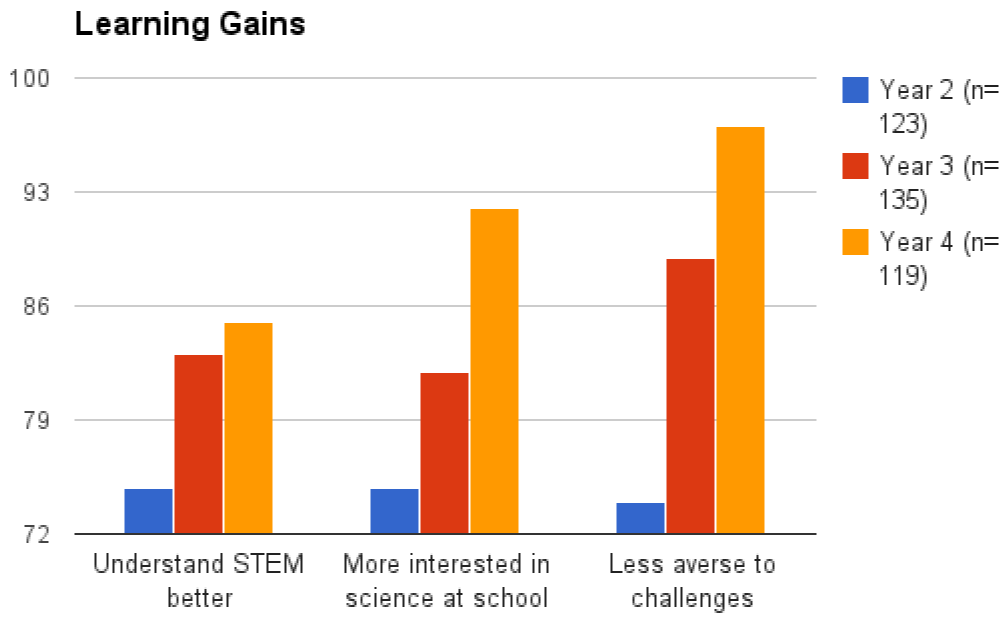

Fig. 3- Learning Gains for Students

After participating in a Family Science Course, students understand STEM better, are more interested in science at school, and are less averse to challenges. From year to year, returning students retain their learning, and continue to develop a better understanding of science and engineering, as well as a more positive attitude towards STEM activities (including building activities, informal science programs, and further exploring areas that pique their interest). Students also exhibit greater persistence and willingness to work through failures and setbacks. Students have also come to take greater ownership of their science and engineering learning through the engineering design process and feel empowered to share what they know with family members or fellow students. [2,3,4]

Parents

After participating in Family Science, parents understand STEM better, are more confident discussing STEM and STEM concepts, and practice more STEM activities at home. Parents learn how to build alongside their children, learn about the concepts behind the designs, and are better able to explain how things work to their children and other family members. Parents develop greater confidence in their abilities to discuss science and engineering, and more importantly express confidence that their children see them as knowledgeable problem solvers. Following their participation in Family Science, parents have a more positive perception of STEM jobs and careers, and engage in more STEM activities at home and out-of-school (including reading more STEM-related books, watching science shows, and visiting more museums) [2,3,4].

Engineering students

Following their participation in the Engineers as Teachers class and facilitation of a Family Science Course, engineering students express positive learning gains and greater confidence in speaking to and teaching non-technical audiences. Through the EasT class, engineering students develop practical skills, including critical thinking, creativity, public speaking, project management, and collaboration skills. Engineers also learn how to develop engineering lesson plans, and how to create successful Engineering Design Challenges. Their science communication skills are improved through the practice of simplifying their language and breaking down complex concepts into simpler, connected concepts--skills necessary to succeed as professionals in the workplace. Engineers also express their enjoyment at pushing beyond their comfort zones by leaving their classrooms to work in the local community, and at the end of the course are more proficient working with children, and with adults outside of the normal class schedule. Engineers develop greater leadership skills (how to be assertive, how to make decisions, how to manage a classroom during hectic hands-on activities etc.) in addition to honing their communication skills. [2,3,4]

Leveraging technology to increase depth and scale

Iridescent is preparing for the 5th and final year of BAS and planning for the future after the program ends. In 2015, we will be running Family Science Courses at 8 schools in Los Angeles and at NYSCI in New York. Our main goal for this year is to build capacity at our partner schools, which will allow the robust learning and engagement with engineering to continue even after the NSF funding concludes at the end of the year.

Over the past two years Iridescent has worked with partners to make Family Science Courses sustainable beyond the parameters of the NSF project. We have worked to create a culture of cooperative learning between parents, engineers, and school administrators. A critical factor for sustainability is to identify natural motivations for each stakeholder to continue working with the other groups after Iridescent reduces its support.

Additionally, in 2008 and 2009, Iridescent conducted large parent surveys (n=361, n= 943) soliciting their interest in Family Science Courses, co-investing, and online learning [5]. 72% of parents were interested in participating in Family Science Courses so that their children could learn new things and make new friends. 73% of parents were willing to donate between $5 and $20 to support Family Science Courses, and 51% were interested in helping organize the courses and in learning how to facilitate science at home. Based on these findings, Iridescent developed an online project based learning platform (www.CuriosityMachine.org) to give parents the necessary knowledge and support to facilitate science at home [1, 6-10].

Increasing parental engagement in STEM education opportunities

As part of the BAS project, we have trained and developed parent leaders at each partner school with the goal of changing the culture of STEM education in the school. In the past 4 years, we have tested various recruitment and retention methods while empowering parents to play a larger role in bringing science and engineering programs to their own school. Below is the summary of the best practices for recruiting and retaining families in the underserved community schools.

Recruitment Method	Practices
Developing Strong Relationships with **Principals**	• Connect with principal and identify staff as Family Science Courses and Curiosity Machine courses champions • Offer schools additional resources (e.g. Profesional Development teacher workshops) • Identify budget constraints and sign a MOU agreeing on responsibilities. • Ask for schools' help to access information and events (e.g. using attendance records • to remind absent families, presenting videos at Back to School nights)
Engaging **Teachers** and **School Staff**	• Present to and invite teachers to Family Science Courses clearly stating the benefit of learning how to teach engineering curriculum. • Identify and develop a strong relationship with after-school program staff.
Engaging **Parents** in Recruitment	• Present to parents at Back to School Nights • Present at school parent centers, PTAs or similar English Learner Advisory Committee(ELACs etc) to recruit parents • Identify and enlist parent leaders to organize logistics for programts

Table 2 - Iridescent's Recruitment Methods

Table 3 lists retention strategies that Iridescent uses to help families remain engaged:

OBSTACLES	RETENTION STRATEGIES
Low education [15, 16, 18, 19, 21, 29, 37]	Materials are visual & help parents to learn while guiding their child
Language barriers [17,20, 25-29]	Instruction is accessible through bilingual materials, on-site translators and by communicating with adults via bilingual children. The direct instruction piece during which engineers explain the concepts is limited to 10 - 15 minutes so the translation process is not tedious for English-speakers.
Logistical issues such as long working hours, multiple jobs [19, 22, 31-33], single parenthood [38,18]	Meals are provided so that adults can free up the required time from preparing dinner. All children are invited to remove child care as a barrier. Family Science Courses are held at convenient times and in familiar locations, i.e. schools.
Cultural attributes [13, 14, 22-24]	Iridescent builds on the support of the family through its emphasis on cooperative learning and by inviting all (toddlers to grandparents) to participate in exploration. The emphasis on cooperative learning is culturally attuned to Hispanic and African-American communities whose "collectivist" cultures can clash with the individualistic nature of most formal education [38, 39,19,20]

Fear of science and a "fixed" mindset	Iridescent makes STEM more accessible to families by presenting it like sports - requiring considerable practice to achieve mastery [1]. By developing a relationship with engineers, families realize that engineers are normal people who need to work just as hard to solve problems.
Supporting exploration at home	Families can access the OEEDCs through the Curiosity Machine and can get free English and Spanish copies of Making Machines books where we disseminate OEEDCs. All experiment materials can be bought at a grocery store at low cost.
Access to technology for the Curiosity Machine	49% of African Americans and Latinos have smartphones compared to 45% of Whites (46% national average) [40-42]. Latino and Black users are equally likely to access the internet from a mobile device at 76% and 73% respectively, compared to 60% of whites [40].

Table 3 -. Retention Strategies

Sustainability Plans

In addition to laying the groundwork for a culture of cooperative learning, we have also developed and launched Curiosity Machine, an online learning community that connects children and their families with scientists and engineers through digital collaboration on engineering design challenges. Children and their families build a design challenge in school, in an after school or community program, or at home, and share their work with a mentor. Mentors are professional engineers and scientists who volunteer their time to work individually with a student builder for the duration of a project. The mentors provide constructive feedback on the student builders designs' just as EasT students do during a Family Science Course. Mentors encourage students to iterate on their designs, offering encouragement and feedback at each stage of the Engineering Design Process in addition to explaining core physics and engineering concepts that are needed to solve the engineering design challenge. Many of our Curiosity Machine mentors are former EasT students, wishing to continue their work with the community.

Part of the parent training at BAS partner schools includes training on how to use Curiosity Machine as a way to continue building and learning in ensuing years. We offer trainings and development sessions for parents at our partner schools, walking through the online platform and reinforcing the tools and skills they have already learned through BAS. Our goal is for these families to continue their science and engineering learning at home, independently (stage 4 of the learning model).

Finally, we are also working to build capacity by partnering with engineering corporations and engineering professional societies, training professional engineers to develop Open Ended Engineering Design Challenges and teach Family Science, adopting the EasT and Family Science model to a professional instead of collegiate setting. This will enable engineering corporations and their engineers to broaden reach in their immediate communities. Through this early work, Iridescent is also conducting a research study on the impacts of training and outreach on employee engagement, job satisfaction, and development of soft skills (including public speaking, communication to laymen, and team management). We understand that employee satisfaction and engagement is a challenge for many large corporations. Projects are complex, requiring large teams and multi-year product cycles, making it difficult for the individual to take full ownership of a product, or feel they have tangibly impacted another person's life. Thus many employees in large corporations express a lack of fulfillment from their work [11, 12]. The EasT model can provide a way to connect with both passion and the community, developing an Engineer's professional skills (communication, presentation, ability to think creatively), while also giving them an opportunity to create something new, test it, and get it to work in a short amount of time. We anticipate that the critical thinking, problem solving, and project management skills that our EasT students acquire through participating in the course will transfer into leadership skills that will prove invaluable in their professional careers. We also believe that creating a robust connection between an engineering company and its immediate community will leave a lasting legacy as they are more likely to continue their collaboration after the initial training and Family Science Course.

In year 2015, we look forward to wrapping up this project. We will continue to build capacity in the underserved communities by training engineering students, teaching Family Science Courses, training parents and school partners, and disseminating design challenge through the Curiosity Machine. We believe that this model is sustainable beyond the length of this grant.

Bibliography

[1] C. Dweck, *Mindset: The New Psychology of Success*. New York, NY: Ballantine, 2007.
[2] H. Ba, "Investigating the Implementation of the Be A Scientist! Project in New York City and Los Angeles: Formative Evaluation, Year One." New York, NY: EDC, Center for Children and Technology, 2011.
[3] H. Ba, "Investigating the Implementation of the Be A Scientist! Project in New York City and Los Angeles: Formative Evaluation, Year Two." New York, NY: EDC, Center for Children and Technology, 2012.
[4] H. Ba, "Investigating the Implementation of the Be A Scientist! Project in New York City and Los Angeles: Formative Evaluation, Year Three." New York, NY: EDC,Center for Children and Technology, 2013.
[5] T. Chklovski. "Results from Iridescent's Parent Needs Surveys." 2009.
[6] W.F. McComas, and L. Abraham. *Asking More Effective Questions*. Los Angeles, CA: Rossier School of Education, University of Southern California.
[7] H.P. Ginsburg, L.S. Lopez, and S.F. Jacobs. *The Teacher's Guide to Flexible Interviewing in the Classroom: Learning What Children Know About Math.* Boston, MA: Allyn & Bacon, 1998.
[8] J. Healy. *Is Your Bed Still There When You Close the Door?* New York, NY: Doubleday, 1992.
[9] C. Wood. *Yardsticks: Children in the Classroom, Ages 4-14*. Third Ed. Turners Falls, MA: Northeast Foundation for Children. 2007.
[10] D. H. Cohen et al. *Observing and Recording the Behavior of Young Children*. New York, NY: Teachers College Press. 2008.
[11] A.D. Botton, *The Pleasures and Sorrows of Work*. New York, NY: Vintage International. 2010.
[12] E. Smith, "There's More to Life Than Being Happy" in *The Atlantic*. 2013.
[13] C.L. Carger, *Of Borders and Dreams: A Mexican-American Experience of Urban Education*. New York, NY: Teachers College Press, 1996.
[14] M.A. Gibson, "The New Latino Diaspora and Educational Policy" in *Education in the New Latino Diaspora: Policy and the Politics of Identity*. Ed. S. Wortham, E.G. Murillo, and E.T. Hamann. Wesport, CT: Ablex Publishing, 2002.
[15] J.L. Epstein, "School/Family/Community Partnerships: Caring for the Children we share." *Phi Delta Kappan* 79 (9): p. 701-711. 1995.
[16] EQUALS, *Family Math and Matematica para la famila*. 1992.
[17] N. F. Chavkin, and D.L. Gonzalez, *Forging partnerships between Mexican American parents and the schools*. Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. 1995.

[18] L. Floyd, "Joining Hands: A Parental Involvement Program". *Urban Education*, 33(1). 1995.
[19] A.S. Sosa, "Involving Hispanic parents in educational activities through collaborative relationships." *Bilingual Research Journal* 21(2): p. 1-8. 1997.
[20] M. Inger, "Increasing the school involvement of Hispanic parents." Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. 1992.
[21] E. Trumbull et. al, *Bridging cultures between home and schools: a guide for teachers*. Mahway, NJ: Lawrence Erlbaum Associates. 2001.
[22] J.A. Bright, "Partners: An urban black community's perspective on the school and home working together." *New Schools, New Communities* 12(3): p. 32-37. 1996.
[23] A.L. Davidson, "Negotiating social differences: Youth's assessments of educator's strategies" *Urban Education* 34: p. 338-369. 1999.
[24] S. Lynch. *Equity and Science Education Reform*. Mahwah, NJ: Lawrence Earlbaum Associates. 2000.
[25] S.M. Shannon. Minority Parent Involvement: A Mexican mother's experience and a teacher's interpretation. *Education & Urban Society* 29(1): p. 71-84. 1996.
[26] N. Hyslop, *Hispanic Parental Involvement in Home Literacy.* Charleston, WV: ERIC Clearinghouse on Reading, English, and Communication. 2000.
[27] S. Lynch, "Science for all is not equal to one size fits all: Linguistic and cultural diversity and science education reform." *Journal of Research in Science Teaching* 38(5): p622-627. 2001.
[28] E.B. Moje et al., "'Maestro, What is Quality?' Language, Literacy and Discourse in Project-Based Science." *Journal of Research in Science Teaching* 38: p. 469-498. 2001.
[29] b. Warren et al., "Re-thinking diversity in learning science: The logic of everyday language." *Journal of Research in Science Teaching.* 38: p.529-552. 2001.
[30] G.R. Lopez, "The value of hard work: Lessons on parent involvement from an (im)migrant household." *Harvard Educational Review* 71(3): p. 416-437. 2001.
[31] F. Fuentes, V.D. Cantu, and R. Stechuk, "Migrant head start: what does it meant to involve parents in program services?" *Children Today* 24(1): p. 16-18. 1996.
[32] C. Delgado-Gaitan, *The power of community: Mobilizing for family and schooling.* Landham, MD: Rowman and Littlefield Publishers, 2001.
[33] W.A. Smih, P.G. Altbach, and K. Lometey, *The racial crisis in American higher education: continuing challenges for the twenty-first century.* Rev. ed SUNY series, Frontiers in Education. Albany, NY: Statue University of New York Press. 2002.
[34] E. Allworth, and B. Hesketh, "Construct-oriented biodata: Capturing change-related and contextually relevant future performance". *International Journal of Selection and Assessment* 7: p. 97- 111. 1999.
[35] E.D. Pulakos, et al. "Adaptability in the workplace: Development of a taxonomy of adaptive performance". *Journal of Applied Psychol-ogy*, 85: p.612-624. 2000.
[36] P. Mussel et al., "Development and validation of the German work- related curiosity scale". *European Journal of Psychological Assessment*, 28(2): p. 109-117. 2012.
[37] O.C. Moses, "Collaboration between schools and disadvantaged parents: obstacles and openings" in *Families and schools in a pluralistic society*. ed. N.F. Chavkin. Albany, NY: State University of New York Press. 1993.
[38] A. P. Scribner, "High Performing Hispanic Schools: An Introduction" in *Lessons from high-performing Hispanic schools: Creating Learning Communities.* ed. P. Reyes, J.D. Scribner, and A.P. Scribner. New York, NY: Teachers College Press. 1999.
[39] C.L. Carger, "Attending to New Voices." *Educational Leadership* 54(7): p. 39-43. 1997.
[40] M.H. Lopez, A. Gonzalez-Barrera, and E. Patten. *Closing the Digital Divide: Latinos and Technology Adoption*. Washington D.C.: Pew Hispanic Center. 2013.
[41] A. Smith. *African Americans and Technology Use: A Demographic Portrait*. Washington D.C.: Pew Research Center. 2014.
[42] K. Zickhur, and A. Smith. *Digital Differences*. Washington D.C.: Pew Internet & American Life Project. 2012.

[43] C. T. Ramey et al., "Early intervention and early experience." *American Psychologist* 53(2): p. 109. 1998.