



Be A Scientist: Family Science for Minorities

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“I enjoyed the experiments, the encouragement toward science, and the engineers’ welcome and support.” – Be a Scientist! Parent

INTRODUCTION

Be a Scientist! (BAS) is a five-year longitudinal study, sponsored by the National Science Foundation (NSF), where undergraduate engineering students are trained to design and teach hands-on Family Science Workshops (FSWs) to underrepresented minority (URM) children and their families. The project’s goal is to provide quality science and engineering courses to families in New York City and Los Angeles and to identify a scalable model for the program. Through this project, engineering students learn to communicate current science, technology, engineering, and mathematics (STEM) concepts to the public and design engineering design challenges related to the concepts. The engineering students then teach the FSWs at an elementary school to children and their families. The project targets families with children in first grade in year one and ending at fifth grade in year five.

The BAS project’s intent is to build a scalable model for STEM learning that involves engineers and families and includes a supporting infrastructure for family and community involvement. The goals are to identify scalable methods of engaging URM audiences and developing their interest in STEM fields. Additionally, the project aims to create a cost-effective, technology-based method of reaching families after the FSWs to ensure persistent STEM interest.

BACKGROUND

Communicating STEM to the Public

In recent years, federal science organizations have encouraged research scientists and engineers to become directly involved in public outreach by requiring them to show the broader impacts of their work outside of academia. For example, the National Science Foundation (NSF) requires researchers to propose an activity that will broaden impact of their work in every funding request. This requirement includes expanding efforts to broaden participation from underrepresented groups. To fulfill this requirement, researchers often partner with K-12 schools, museums and other community organizations to design public outreach programs that will target underserved communities. While there is a lot of encouragement to directly involve engineers and scientists in delivering the outreach programs, very few programs incorporate communication training for them. Resources for communicating science to the public are mainly online such as the website, "Communicating Science: Tools for Scientists and Engineers" created by the NSF and the American Association for the Advancement of Science to help scientists and engineers communicate better with the public. The website offers webinars, how-to tips for media interviews, strategies for identifying public outreach opportunities, and workshops for scientists and engineers who are interested in learning more about science communication [1].

STEM Programs and the Importance of Parent Involvement

Many URM children and their families are not aware of current science and engineering developments. Usually, their opportunities to learn about cutting-edge STEM research and have direct interactions with scientists and engineers are very limited or non-existent. The scarcity of academic support, informal and formal mentorship, and academic role models within friend and family networks exacerbate the educational challenges that children from these communities face [2-4]. As a result, they are underrepresented in STEM fields.

Parents, universities and informal science education organizations present a rich, untapped resource for improving children's engagement in STEM fields [5-6]. STEM curriculum and programs targeting families have been designed and usually train teachers or other educators to deliver the content. Examples of family science programs and curriculum include the EQUALS Family Science Program [7], and the 4-H family program [8]. These types of family-based programs have been shown to be particularly important in boosting the achievement of underserved students [9-11].

Studies have established the link between parent involvement and improved student achievement as well as the benefits of families learning together [12-14]. However, other studies and our experiences indicate that although minority parents care very much about their children's education they face significant obstacles to being involved [15-16]. In order to increase parent-involvement, programs targeting minorities should address low education levels, language barriers, and constraints that affect participation (such as parents' long working hours or multiple jobs) [17]. Much research shows that minority parents support their child's education more readily when they feel empowered [18-19]. Key factors that enable sustained parental involvement are: 1) incorporating parent feedback into the program design and 2) providing continued support post-training and gradually reducing the support over 3-4 years [18].

PROJECT APPROACH AND IMPLEMENTATION

The BAS project build upon research in STEM learning, parent involvement and family learning. The project targets families and emphasizes STEM learning while involving undergraduate engineers as STEM instructors. Children and their families have the opportunity to learn science together and engage in the engineering design process. The program trains engineering students to develop content that communicates science and engineering developments and allows for hands-on experimentation.

Appropriate approach for target audience: The BAS program model overcomes parent's low education levels by designing materials that enable them to develop their own skills while facilitating their child's learning. The language barrier is addressed by providing bilingual materials, on-site translators and by communicating with adults via 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. Constraints such as lack of time are

mitigated by providing meals so that adults can free up the required time from preparing dinner, involving all the children to remove child care costs and by holding workshops at convenient times and in safe, familiar locations (e.g. school sites and community organizations).

Out-of-school-time venues were selected for this program as they allow for sustained experiences with science and engineering, learner choice, low-stakes learner assessments and for reaching URM audiences. These venues also enable face-to-face interactions between the engineering students and families that foster an “I can be a scientist!” feeling among the participants. The project provides FSWs to the same families at 8 partner schools each year. The goal is to follow the families of children from grades 1-5. The partner schools were selected based on demographics (high percentage of Latino and/or African-American children) and percentage of children that qualify for the federal free or reduced lunch program.

Family-directed learning: The FSWs aim to foster participants’ intrinsic motivation and self-direction to learn so that they become lifelong explorers. Since the participants’ prior knowledge of the problem at hand is limited, engineers first introduce the core concepts through multimedia. After instruction, families have the freedom to evaluate and shape their learning. As the families gain deeper knowledge, they would have more control in shaping the direction of their learning.

Engineering students as instructors: The project enables engineering students to directly impact the STEM pipeline by serving as role models and providing meaningful science learning experiences to the public. Undergraduate engineering students enroll in a semester-long course that trains them to bring exciting and inspiring aspects of science and engineering research to the public. As part of the course, undergraduate engineering students design and teach a five-week FSW based on their own science interests and/or research. The engineering students develop their public speaking and leadership skills and a deeper understanding of their own field while communicating complex concepts to large, diverse audiences. The FSWs also add deeper meaning to the engineers' work through personal validation, connection and gratification from clarifying complex topics for the public.

Focus on current STEM research: The FSWs bring the most exciting and inspiring aspects of science directly to the public. Thus workshop topics include medical imaging, fluid dynamics, nanotechnology and material science. The program design is based on motivation theory [20], allowing participants to first discover the rewards of curiosity so that they will be motivated to persist and master the basics.

University and museum partnerships: The project engages partners that bring experience in STEM research and teaching. The Viterbi School of Engineering at the University of Southern California (USC) and the Albert Nerken Engineering department at The Cooper Union provide access to university-based research and engineering students. The Natural History Museum of Los Angeles and the New York Hall of Science provide venues and informal science training to the engineering students.

EVALUATION METHODS

The project evaluation is being conducted by the Education Development Center's Center for Children and Technology (CCT). CCT will investigate the overall project's impact on families' STEM learning and effectiveness in achieving broader dissemination and a scalable model.

The overall evaluation is guided by the following research questions:

- 1.) Is the development and implementation of project materials, recruitment strategies, training, and course activities well designed and integrated into the project's goals?
- 2.) How do participants experience the project?
- 3.) What is the impact of the project on families, undergraduate engineering students?

Data were gathered using surveys, interviews, concept mapping, and program observations. CCT researchers collected relevant project documents (e.g., meeting notes, videos), surveyed 63 parents and 119 students, conducted 2 site observations at both the New York and Los Angeles FSWs, and interviewed 4 project staff and 3 partners. Data has been collected and analyzed for the first two years of the project and focuses on the impact to date on parents, children and engineering students. CCT researchers employed both quantitative (surveys) and qualitative methods (teacher logs, interviews, and observations) of analysis on the data collected. For quantitative data SPSS was used to conduct descriptive data analyses.

FINDINGS

The following findings focus on the impact that program participation had on parents, children and undergraduate engineers during the first two years of the project.

Impact on Parents

The parents who participated in the BAS project indicated that they benefited in the first year of the project through the process of learning and relearning, and building successful challenges. They demonstrated abilities to explore and be curious about science experiments and engineering, and while learning about scientific concepts (energy, density, gravity, friction, inertia, and aerodynamics). Most parents (76%) accompanied their children to the workshops and enjoyed learning the science content. However, the highlight for them was the building, testing, and redesigning of the hands-on engineering design challenges. Through observations, evaluators found that parents were very much involved in building the engineering design challenges. They often were so enthusiastic that they took over the child's project and made it for them. Parents expressed that they enjoyed spending time as a family to learn about science and after attending the program

realized how easy it is to make science activities using everyday objects and materials.

Many of the parents returned to the program for the second year because they had such a positive experience. Findings from surveys administered during Year 2 of the project show that parents learned about how common objects and machines function and they felt that they are more able to explain how things work to their children and other family members. More than three-quarters of parents surveyed (77.8%) reported that they understand science and engineering better after attending the program and two-thirds of parents (66.6%) indicated they were more confident talking about science and engineering topics with others. As a result of attending the program, parents report that there are more science-related activities going on in their homes such as building things, playing with science kits, watching science programs, and going to museums and zoos. On the survey, 88.9% of parents also reported that they will read more science books with their children. Many parents expressed feeling more confident because their children see them as people who know things, who can build things and who can solve problems.

Impact on Children

Participating in FSWs also had a number of positive impacts on the children attending the sessions. Most of the children were interested and engaged in learning science, enjoyed the learning process, liked to explore different ways to build their experiments, and were comfortable learning in a positive environment. They often remembered what they learned or did the previous week. As a result of their participation in the BAS project, they began to own their science and engineering learning through the design inquiry process. The hands-on building process afforded children the opportunity to ask a lot of questions about the quality and strength of different materials, and make certain decisions about their design. In most lessons, children asked design and redesign questions: “How can I make my shock absorber stronger?”, “Why doesn’t my rocket go straight?”, “What ball worked better and why?”, “What kinds of wings can we make?”, and “Why are lighter materials better.?”

Second year project findings show children are learning new concepts and vocabulary and actually remembering them weeks and months after the class is over. In fact, nearly three quarters (74.8%) of children reported that since participating in Family Science, they have a better understanding of science and engineering.

Children said they share their knowledge with their siblings and friends after they learn something interesting in the Family Science Workshop. The children feel empowered to share what they know with others. Some children have been inspired to become scientists. They have gained confidence in their scientific knowledge and ability. Three quarters (75%) of children reported now being more interested in science at school. At home children are eager to seek out more information about various scientific topics on the Internet. They are going to more science specific websites like Sid the Science Kid and Electric Company to learn more about science and engineering. Children are more creative. Instead of just drawing, they now want to build and invent things. They want to experiment and make more things at home. Two thirds of children (64.7%) reported that they are doing more science related activities with their families. According to one of the

engineering students, over the course of the class, children begin thinking more outside of the box, moving away from copying one image or product. They are more adept at creating and inventing their own designs. Children reported being less averse to challenges and challenging activities (74.0%). Nearly all of these children also reported that they would be more likely to keep trying to complete a project even if they couldn't figure something out on the first attempt.

Impact on Engineering Students

The undergraduate engineering students reported a number of positive outcomes from their experience in the semester-long course. Students commented that they learned practical skills, such as critical thinking, creativity, public speaking, and collaboration skills that they didn't necessarily learn in other classes. Because they were communicating with an audience with little engineering background, the engineering students learned how to simplify their language and break down complex content into simpler concepts. Instead of building to create a set of results, which they often do in their other classes, the engineering students felt that teaching this course helped them understand that there can be many solutions to one problem.

Students were "inspired" by the multiple and varied designs created by the children in the Family Science class; it reminded them that there is rarely just one right answer to a problem. Seeing the children's excitement and fascination with building and designing reminded some of the engineering students of why they became engineers in the first place. It reminded them of the fundamental enjoyment of creating things and taking them apart. Being reminded of these basic emotions was inspiring and motivating for them.

CONCLUSION AND FUTURE WORK

Findings show that the BAS project is bringing current science and engineering research to the public, impacting the STEM pipeline by bringing social capital (undergraduate engineers) to underserved communities and providing a model for families to learn STEM concepts and build projects together. As a result of participating in this program, parents and children are doing more science activities at home and on their own time. It is increasing confidence in their abilities to do STEM projects. Additionally, the model has an effect on the engineering students instructors. Participation is reinvigorating engineering students' interest in the engineering field, improving their communication skills and increasing awareness of the engineering design process.

The next steps of this project are in identifying factors that develop persistent participant interest in STEM and sustain the program beyond the project duration. Our goal is to create a sense of community among participants to encourage continued and sustained family engagement. A parent leadership program is currently being piloted. It aims to empower parents to co-invest in and sustain the program in their community. Parents are invited to participate in the leadership program that gives them the skills to coordinate the FSWs. They can opt to help in translation, organizing materials and facilitating FSW activities. This opportunity will enable them to develop and practice valuable skills of

leadership and entrepreneurship in addition to helping them build their sense of self-efficacy.

Additionally, we have begun the development of an online web-based portal that will allow families to continue learning STEM concepts and sharing engineering design projects they develop at home. It will include supporting materials for parents so that they can facilitate the activities with their children including high quality videos of science and engineering researchers explaining their work and highlighting their labs.

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