

The Exploratorium's XTech Program:

Engaging STEM Experiences for  
Middle-School Youth

Summative Evaluation Report

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*I like how complex science is. Science really is amazing.*  
XTech Youth Participant

## INTRODUCTION

### Background

The Exploratorium is home to XTech, a science education program which began in 2006 and was primarily funded by a three-year National Science Foundation grant (Award # 05-25217) through its ITEST (Innovative Technology Experiences for Students and Teachers) initiative.<sup>1</sup> XTech provided project-based afterschool activities in science, engineering, and technology to underserved middle school students from the San Francisco Bay Area. As part of the Exploratorium's Community Outreach department, XTech involved partnerships with two community-based organizations in the Bay Area – Aim High and First Graduate<sup>2</sup> – that support youth in educational pursuits.

The goal of the XTech project is to steer underserved students in positive directions, towards college and potential careers in the fields of science, technology and engineering. Through two years of intensive summer institutes and afterschool and weekend sessions during the school year, middle school students spent hundreds of hours in Exploratorium classrooms, on the exhibit floor, and on field trips engaging in activities that incorporated art, science concepts, engineering, problem-solving, and information technology. For example, they learned about electricity and wiring circuits; explored the inside of a computer; learned how to use hand tools and operate simple machinery; and learned how to design and build individual projects such as laser light machines, art-robots, green screen films, light paintings, and automata. Added incentives included assistance with transportation, and stipends for students once they participated for a certain number of hours. XTech staff included experienced Exploratorium educators as well as 10 to 15 youth facilitators hired through the museum's successful High School Explainer Program. The ethnically and culturally diverse youth facilitators served not only as educators and guides, but also as mentors and role models for the students.

Cohort 1 began in the summer of 2007 and served 80 youth. The second cohort with an additional 51 students began their two-year program in the summer of 2008.

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<sup>1</sup> To learn more about ITEST, see <http://itestlrc.edc.org/>. Additional funding for XTech came from the David B. Gold Foundation, JP Morgan Chase, and Symantec Corporate Giving.

<sup>2</sup> For more information about Aim High and First Graduate, see <http://www.aimhigh.org> and <http://www.firstgraduate.org>.

Originally, the project involved a partnership between the Beacon Youth and Family Centers<sup>3</sup> and the Exploratorium. XTech intended to provide activities at several Beacon Center sites as part of the Centers' afterschool drop-in program. Youth participation in the first semester of programming was low, and logistics became impractical; mid-year in the first year, the Exploratorium made the decision to partner instead with Aim High and First Graduate.

## Evaluation

Inverness Research<sup>4</sup> was hired to conduct a summative evaluation of the XTech project. Our work included:

- interviews with XTech staff
- program observations
- interviews with student participants and youth facilitators
- focus groups with youth facilitators
- interviews with key staff from Aim High and First Graduate
- surveys of student participants<sup>5</sup>
- informal interviews with parents

This report presents our findings on the XTech project. First, we discuss the theory of action that drove the project. We then discuss the value and contributions of the project to student participants, youth facilitators, and participating organizations. Finally, we address the lessons learned about this investment.

## THEORY OF ACTION

The XTech project held a theory of action that by partnering with local community organizations that focus on underserved youth, they could create a situation in which each group would benefit. The community organizations would provide the students that the XTech program was hoping to reach, and the Exploratorium would provide innovative science and technology-based programming in a dynamic, STEM-infused venue. While the Exploratorium has a history of successfully providing these kinds of experiences in a short-term context through summer programming, XTech funding provided an opportunity to offer longer-term programming that would run two summers and two academic years and be geared specifically to underserved students.

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<sup>3</sup> For more information on the Beacon Youth and Family Centers, an initiative to support at-risk youth in the Bay Area, see their website at <http://www.beaconcenter.org>.

<sup>4</sup> For more information on Inverness Research, Inc. see <http://www.inverness-research.org>.

<sup>5</sup> Final surveys were administered at the graduation ceremonies in February and March of 2009. A total of 28 youth participants completed surveys.

Additionally, the XTech project is driven by a theory of action which asserts that middle school students benefit from opportunities to learn science and technology through a combination of the creation of personally meaningful artifacts, an exploration of Exploratorium exhibits, regular interaction with Exploratorium staff and youth facilitators, and field trips to see and experience STEM in action.

The projects that youth participants in XTech work on involve “constructionism: the construction of knowledge in the context of building personally meaningful artifacts.”<sup>6</sup> The theory behind constructionism is that by designing and making something, one learns a variety of new skills, knowledge, and attitudes. This is inquiry in the context of design: where youth envision something, try it, refine it, and try it again. Youth learn through having to design under constraints (limited materials, limited time, a frame that places boundaries around their building activity, etc.). They are empowered to engage with materials, create something with them, and learn from those materials. Their curiosity is nurtured. As youth succeed in this adventure of tinkering and making things, they continually expand their zone of proximal development so they gain greater capacity and greater confidence to design and build. In the XTech program, youth engage with art, science, and technology simultaneously. What youth gain from participating in these experiences is not so much content-specific as it is about empowerment and confidence building.

Finally, another layer of XTech’s theory of action is that these tinkering and exploration experiences work best when they happen in the context of a positive peer culture. For most of the projects, youth work together in pairs or small groups. This culture involves not only working collaboratively with friends from their own schools, but also youth from around the Bay area that they might not have the opportunity to interact with otherwise. Positive peer culture is also created through the high adult to youth ratio. The project provided for the involvement of former members of the Exploratorium’s successful high school Explainer program, many of whom still want to be involved with the museum after graduating from that program. The project leaders believed that some of these young, former Explainers would benefit personally and professionally from opportunities to teach and facilitate middle school-age youth in these technology-based experiences, and that the middle schoolers would benefit from having long-term relationships with college-age youth who serve as role models and sources of inspiration. The Exploratorium itself – with its enthusiastic zest-for-learning atmosphere – and the staff who generously engage youth throughout the museum, provided yet another setting for XTech’s positive peer culture.

In summary, the Exploratorium’s XTech project sought to create long-term, meaningful experiences for middle school students, serve the programmatic needs of local

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<sup>6</sup> For more about constructionism, see Seymour Papert and Idit Harel’s work *Constructionism*. Ablex Publishing Corporation, 1991.

community-based organizations, and provide opportunities for past Explainers to continue their involvement with the Exploratorium and take their facilitation skills to another level. To a great extent, this theory of action came to fruition through the XTech program.

## PROJECT BENEFITS AND CONTRIBUTIONS

In this section of the report, we outline the project's benefits and contributions to the youth participants, to the youth facilitators who worked with the middle school students, and to the partnering organizations (AIM High, First Graduate, and the Exploratorium).

### BENEFITS TO YOUTH PARTICIPANTS

#### **Self-Directed Learning**

XTech provided a powerful combination of experiences for the youth participants. By combining tool technology, computer technology, a wealth of materials and resources, and by encouraging personal creativity in the construction of science-rich projects, valuable experiences were created that engaged the youth. The project inspired them to learn science in an applied way, to direct their own learning experiences, to ask questions, be playful, follow their curiosity, take risks, and become empowered through the creation of interesting artifacts. We believe that the combination of scientific thinking with design thinking is profoundly important for the development of young people who may become part of the 21<sup>st</sup> century STEM workforce. As Charles Owen, Distinguished Professor Emeritus, Illinois Institute of Technology, said of design thinking and its importance:

*Design thinking is in many ways the obverse of scientific thinking. Where the scientist sifts facts to discover patterns and insights, the designer invents new patterns and concepts to address facts and possibilities. In a world with growing problems that desperately need understanding and insight, there is also great need for ideas that can blend that understanding and insight in creative new solutions.<sup>7</sup>*

XTech provided multiple activities through which youth participants could engage in self-directed learning, collaborations, and inventive thinking. Youth participants, staff and facilitators working with youth, as well as parents all reported that youth learned many things from their participation in the project. The kind of learning was not so much school-like, conventional science and technology learning (although that happened to some extent as well), but rather was primarily focused on process skills

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<sup>7</sup> Owen, Charles. *Design Thinking: Notes on its Nature and Use*. [Design Research Quarterly](http://trex.id.iit.edu/ideas/papers_j.html) Vol. 2, No. 1, January 1007, pp. 16-27 [http://trex.id.iit.edu/ideas/papers\\_j.html](http://trex.id.iit.edu/ideas/papers_j.html).

and phenomenological kinds of learning – exploring materials and phenomena and building fluency in those areas. Building fluency with materials, with tools, with the design process, and with the way things work were all important goals of XTech which contributed to participants’ self-directed learning.

### Science and technology

The science and technology youth engage with in the XTech project involve areas not only where rich explorations are possible, but also where the Exploratorium has exhibits, collections, and expertise as well. These areas of science and technology – such as light, sound, electricity, and biology – are explored in such a way that youth are encouraged not only to understand the basic underlying concepts, but also to apply these principles and concepts. Two students reflected:

*I learned about physics, about gravity and forces. I learned about electricity, light and circuits and motors. I learned electronics and technical stuff.<sup>8</sup>*

*They teach us like cool vocabulary, like the dimmers they call potentiometers. And then we know the scientific name for it.*

One youth facilitator spoke of how important the application of science and technology was to the participants’ understanding of what they were studying:

*They see science being applied here, and that helps them understand it better.*

When we asked participants what specific things they learned from participating in XTech, many of them spoke with confidence about their understanding of how to “do” something with the science and technology they learned. For example:

*I like learning about wiring because someday if I build a house I’ll be able to do the wiring.*

*The most important things I learned were how everything in my house works. I now know that a light bulb in a house is more complex than turning on a switch...*

Students learned not only from constructing things, but also from de-constructing things. By taking things apart, they figured out how they work. One 7<sup>th</sup> grade girl showed us the string machine she made and how it was supposed to work. She mentioned that at XTech, they sometimes learned about what’s inside of things. She pointed to the motor and said that they got to see inside one. With excitement, she said, “it’s got magnets inside!”

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<sup>8</sup> Quotes have been lightly edited for clarity.

Several participants shared examples of going home from the program and helping older brothers and sisters fix things, as this example illustrates:

*This one time, my older brother had a project and he had to fix something and it involved circuits. And I knew how to make a parallel circuit. So I said, "I know how to make it." And he was like, "Oh wow! Thank you!"*

Parents also noted how important the project work had been not only for their children's understanding of science, but also for their enjoyment of it.

*They learn how different materials work. They learn how to do things from the ground up.*

*We're so happy because he likes [XTech] and when he likes it, he learns.*

Several youth participants, both in their final interviews with us and the final survey comments, spoke of how what they had learned at the Exploratorium was going to help them in school and in the future:

*The most important things I learned were flight, circuits, animation, and light. They might better me in the future in college and high school.*

*I have a better understanding of life, earth, and physical science which is helping me in high school. I am going to take honors biology next year.*

Finally, one participant noted how her perception of science had changed during her participation in the program:

*I like how complex science is. Science really is amazing.*

#### How to use a variety of tools

Youth participants became comfortable and skilled with using a variety of tools – everything from drills, hammers, and screwdrivers to tape measures, table saws, and soldering irons. Most students had no prior experience with tool use. Learning the safe and skillful operation of tools was an important source of pride for many of the participants, as these comments from the final survey illustrate:

*I am comfortable now using any tool.*

*I can easily use a wire stripper, wood sander, woodcutter, the drills, glue guns and so many other tools.*

And as one parent noted proudly:

*He learned how to use machinery and saws. He didn't make things before.*

### Learning about careers

The program targets middle school-age students, many of whom indicated they did not yet know which careers they were interested in pursuing. For some, however, their participation in XTech – their personal experiences, their interactions with staff and youth facilitators, and the field trips – influenced their thinking about their future careers. The following responses from the final survey and interviews highlight some of the ways in which the program influenced the career thinking of participants:

*I am thinking about being an engineer or scientist.*

*I want to be an engineer now. I didn't know what I wanted to be before.*

*I like working with tools, building things. I plan on building car engines for my career.*

### **Inventive Thinking**

XTech participants were encouraged to develop many aspects of creative and inventive thinking<sup>9</sup> through the projects they constructed and experimented with, and they highly valued those elements of the program that allowed them to explore their creative and expressive selves. One youth told us about how the designing and building of his cardboard automata involved a great deal of creative thinking:

*[Building the automata] was neat. It was our decision of how we created and designed our own thing. So it was like more of a creativity project. We had to figure out how to make our machine turn or go up and down or side-to-side, so creativity was mixed in with a lot of thinking.*

Parents noted the creativity fostered in their children as well. As one parent said:

*He's more creative since coming here; he's doing more creative things at home.*

### Questioning Attitude

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<sup>9</sup> Charles Owen, in the previously noted article, compiled a list of characteristics of creative thinking from multiple sources. These characteristics include: sensitivity, questioning attitude, asymmetrical thinking/redefinition, personal courage, sustained curiosity, dedication and willingness to work, fluency of thinking, flexibility, and originality.



Another key benefit for youth participants was in gaining a questioning attitude, which is essential to creative thinking. Asking questions and trying to figure things out was strongly encouraged by staff. Knowing that one does not have all the answers, and that one can ask for help when needed or draw upon a variety of resources, was also an important outcome for youth participants. As one participant noted:

*I learned how not to be shy and ask for help. I usually have a problem with asking for help because I think it makes you feel vulnerable. But I learned it helps to ask for help, because then you know what you need to do, and you learn more by asking for help.*

One museum staff person noted that participants got better over time at asking for help:

*When the youth first come here, they are shy and they also think they know it all. Over the course of the program, that improves—they are more open, more willing to ask questions and more willing to learn.*

## **Relationships and Collaboration**

For middle school students, as important as the learning is the context of relationships in which that learning occurs. XTech provided opportunities for many positive relationships and collaborations – among youth participants, between youth participants and youth facilitators and adult staff, and with the larger museum itself.

### Positive peer culture

Observations of the program revealed a positive peer culture among participants and a high degree to which they became comfortable and at-home in the Exploratorium, as reflected in this student's comment:

*If I could change one thing, it would be how long I could stay here. I would like to spend more time here with my friends and family.*

In interviews and on surveys, one of the most frequent comments from participants was about the positive social interactions they had with their peers and older youth in the program. Some of the participants were already friends from their time together in Aim High or First Graduate. However, the project provided many of the participants with a unique opportunity to step outside of their comfort zones and interact with youth from other ethnic backgrounds and from other parts of the city with whom they normally would not interact. Students said:

*I met a lot of good friends here. We even talk outside of the program now.*

*The highlights [of the program] were making new friends and getting to know my other friends better.*

Through working on projects in teams, exploring the exhibits together, and participating in field trips, the youth not only learned science, but also learned about and came to appreciate each other and the youth facilitators who were working with them. The result was that a new peer group was formed: one centered on science and technology learning and experiences. For many of the participants, the learning and social aspects were tightly tied, as these comments illustrate:

*I feel that I am coming to the Exploratorium to see my friends and learn at the same time.*

*I made friends and made things, and I learned a lot of science.*

Adults working with the youth, as well as parents, appreciated the social growth that took place. One staff person noted the change she had observed in students over the course of the project:

*It is very interesting to see a shy student at the beginning and then see him or her speaking out and wanting to learn and reaching out to other students and being friends. Here you get to find friends from different schools and neighborhoods.*

Several parents also commented on how important the social development of their children was at this critical time of transition from middle school to high school. One parent reflected:

*I think the program helped him socially. He's going to a big high school next year and I think that would have been tough for him, but he has had some experiences now [through XTech] meeting new kids.*

Youth facilitators noted the importance to society in general of having youth and youth facilitators from different cultures come to learn about and trust one another. One facilitator stated:

*I think everyone here is more open to different cultures now. We have youth facilitators and students and staff that come from all different kinds of backgrounds. And you see the students becoming more comfortable and open to people from different cultures. It's good. They trust each other and they trust us.*

### Relationship between youth facilitators and youth participants

One key aspect of the positive peer culture created by the program was the relationships that formed between the youth facilitators and the youth participants. As one student said:

*[The youth facilitators] are nice. They know how to play and how to be serious. They have learned about us and they know our strengths and our weaknesses and they help us with our weaknesses and make us get better at our strengths.*

It is sometimes difficult to create authentic, meaningful mentoring relationships between older and younger youth. XTech was highly successful at creating situations where these positive relationships could develop. For example, we believe that engaging in construction and tinkering projects provided a good vehicle for youth facilitators to interact with the younger participants and offer their playful, friendly support and assistance. In our program observations, we regularly observed high-quality relationships and rapport between participants and youth facilitators. From the participants' perspective, learning science and technology from people who were only slightly older than them was an important component of the program. Youth facilitators shared with participants their insights and experiences from high school and college, and were positive role models for the youth participants. These statements from both a program leader and a participant illustrate the value of the connections that youth facilitators made with students:

*The students are learning science hands-on from people who are close to their age. It connects them a little. They know how to talk to them and it is easy for them to communicate.*

*It is fun to have someone who is not old explain things to us.*

### Relationship with the Exploratorium

The Exploratorium is a unique, exhilarating place, and participation in the XTech program granted youth and their families access and a special behind-the-scenes knowledge and experience of the museum. Youth and parents both valued this opportunity to come to know the Exploratorium better. The program liaisons with both Aim High and First Graduate noted that this special access that XTech provided to their students and families was a valuable benefit:

*For our families, having access to the Exploratorium is a big plus.*

*There is really good power of place when it comes to the Exploratorium. It is such a neat museum, and I think these kids feel a sense of belonging there. They are part of the Exploratorium. They can walk in, go to their space and have*

*access to equipment. It is powerful for them to feel that they have access to such a facility.*

All of the participants we interviewed, and all of the youth who completed final surveys at graduation, indicated they were interested in becoming an Explainer or youth facilitator at the Exploratorium. This comment from the final participant survey was indicative of many of the comments:

*I had a good time in my two years of working at the Exploratorium and I want to work here in the future.*

Parents also were interested in having their children continue their relationship with the museum. Almost all of the parents we interviewed noted that the Exploratorium provided a safe, productive place for their children to be, away from computer and video games. Parents valued the real-life experiences, and the opportunity to work with real materials as an important alternative to the television/computer/video-based cultures in which many of these youth live. Thus, in much the same way that the program created a positive, alternative peer culture centered on science, art and technology, the museum offered a safe haven and stimulating alternative to the sometimes-isolating trends of modern culture.

### **Personal Growth, Responsibility, Commitment**

As we mentioned in the theory of action section of this report, the types of tinkering and construction projects at the heart of the XTech project provided opportunities for youth to take risks, learn from their work, and gain confidence. Youth were empowered by their ability to see projects through to completion and to successfully envision their ideas and build them. This, coupled with the social interactions that were so positive, contributed to building the participants' confidence. Youth felt great pride in their accomplishments and highly valued those projects that seemed to challenge them the most. Students spoke of taking their projects home to their families and to school to show them off. Several students in their final survey comments linked the knowledge they had gained with their increased confidence, as reflected in these comments:

*I feel more confident and knowledgeable [since coming here].*

*I feel good. When I came in, I was not that good at science. I enjoy it now.*

Two other students in their final surveys indicated that the highlight of XTech for them was in working hard to complete something:

*[The highlights for me were] the parts where I had to push myself to do something.*

*I liked the Laser Lissajous project the best, because it took a lot of work and time, and I finally finished it and it was a really great achievement.*

The youth facilitators also noted participants' increased willingness to take risks and the accompanying increases in their self-esteem. As one facilitator noted:

*Their willingness to try really grew in the program. Their confidence improved.*

Participants' responsibility and commitment to the XTech project was supported and rewarded in several ways. The program provided stipends to participants when they reached specific benchmarks of hours completed (150 hours for the first benchmark; 240 hours for the second). More than three-fourths of the participants from cohort 1 and 2 had over 150 hours by spring 2009; 14 youth had reached their 240 hours by spring 2009. They got to attend special, all-expenses-paid field trips, (e.g., "sky-diving" in a wind tunnel), and they had snacks provided at each session. Students and their families had to arrange for transportation to the museum to participate in the academic-year project work. Through their commitment and dedication to the project, students gained responsibility. As the program associate at First Graduate noted:

*This idea of demonstrating commitment and effort and getting a reward for it is important. Students and families have to demonstrate a certain degree of independence and follow-through.*

The following vignette illustrates the value and contribution of the XTech program to its youth participants.

"James," an African American male, arrived at his XTech graduation ceremony with 12 members of his extended family—his parents, grandmother, sisters, brothers, nieces, nephews, and cousins. His participation in and successful completion of his 240 hours in the program was clearly a major milestone and source of celebration for this family. They photographed him standing next to each and every relative, holding his stipend check next to his smiling face.

When we interviewed him, he told us how much he really loved the program. He said he liked everything about it, but especially that it was fun, he learned a lot, and it gave him the opportunity to make new friends. Most of all, participating in the project and completing the 240-hour commitment gave him a sense of accomplishment. He said, "*I am really proud of what I have done here.*"

His parents were very supportive of his participation, and felt the program had been a significant and meaningful experience for their son. His mom noted that he would come home and share with his family what he learned. She said, "*He told us about the cow's eye dissection and showed us the turbulent orb. He went from our house to his grandparents' house to show them. Everyone was interested—we all wanted to know about it and he wanted to share it with us.*"

Most importantly to his parents, they felt their son's participation in XTech had helped him with his schoolwork. *"It raised his scores in science. He scored at the honors level on one test. The problem solving he did here was so helpful, and the hands-on engagement really put him in that gear."*

Even though his XTech program is finished, he indicated that he wants to find ways to stay involved with the Exploratorium: *"I want to work here!"*

### BENEFITS TO YOUTH FACILITATORS

As we stated in an earlier section of this report, part of the project's theory of action is that older youth who had graduated out of the Exploratorium's Explainer program would be ideal facilitators for middle-school aged youth experiences, and would benefit from the opportunity to refine their teaching and facilitation skills in a slightly different vein than they had in the Explainer program. Our evaluation findings indicate that this theory played out much as the project leaders believed it would. As we explained in the "benefits to youth participants" section above, the relationships formed between youth participants and youth facilitators were highly positive. And, as we will discuss in this section, youth facilitators benefited greatly from their work with the project.

In some ways, youth facilitators gained in areas similar to those the youth participants benefited from: they gained knowledge about how to use tools, specific science concepts, and problem solving. As one youth facilitator noted:

*I think the top two things I learned would be people skills and problem solving. We can only actually hit so many problems when we build this stuff ourselves. But if we have ten kids building the exact same thing, everybody has a different problem. We can sit down and figure it out. With people skills, we can learn how to communicate correctly, how to work together, how to make other people work together, and learn leadership skills.*

Concepts the facilitators learned working for the XTech project reinforced the science learning they had experienced earlier in life. One youth facilitator commented that the combination of doing hands-on construction activities and facilitating those activities helped him learn specific science concepts in more depth:

*I took physics in high school and I have learned about electrical stuff all of my life, but it has never really stuck as much as it has after doing this. I feel like I*

*have really learned a lot about wiring and how things go, just by using stuff. You learn something more by teaching it.*

Several others appreciated having to design an activity for the middle school youth and how that improved their teaching skills and confidence level:

*I learned how to teach. The staff was really pushing me. I learned how to explain things which will be really helpful to me in my career as a teacher.*

*I can talk to anyone now. I used to be so shy.*

Similar to what the youth participants experienced, youth facilitators also benefited from the positive relationships and peer culture that developed, both with one another and with the youth participants. They valued the opportunity the project provided them to have long-term relationships with the participants, something they didn't have an opportunity to do as Explainers. They also valued the reflection sessions that program staff conducted, in which the facilitators reflected on their work with the participants, and on the training they received from staff on how to facilitate these experiences. Most of all, they valued learning from one another, as this quote illustrates:

*It is good to get to know more people. I became close friends with people here. It is so good to learn from each other.*

For a few of the youth facilitators, the experience was life changing. One facilitator we interviewed talked about how, prior to the XTech project, he had been unsure about his future. He felt that while the XTech project had not helped him identify a specific pathway, it did help him realize the need to move forward with his life. He said:

*It's helped me get my life on track. I want to be in a different place in the coming years than I have been.*

Another youth facilitator noted that his participation in XTech had influenced his career and college plans. Because of his work with XTech students and the Garage Band computer program on sound projects, he now wants to be a sound engineer.

#### BENEFITS TO PARTNERING ORGANIZATIONS

Another central component of the project's theory of action was the potential for the project to create mutually beneficial relationships with local community-based organizations. The community organizations would benefit from having a world-renowned science museum provide to their youth innovative, cutting edge science and technology experiential education – something the organizations weren't equipped to

provide. The Exploratorium would benefit from having a program through which they could expand their offerings with these organizations – to provide both academic year as well as summer programming, and to build and expand relationships with additional organizations in the community. Most importantly, the Exploratorium would benefit from drawing youth participants from the middle schools in the diverse neighborhoods these organizations serve.

Although the relationship with the Beacon Center was not realized the way it was initially planned,<sup>10</sup> the project was able to build successful relationships with Aim High and First Graduate. While Aim High already had a longstanding relationship with the Exploratorium (since Aim High youth have participated in summer programs at the Exploratorium for many years), the XTech project provided the opportunity to increase the number of Aim High students participating in science and technology programming with the Exploratorium, and allowed for not just summer interaction but also academic year support over the course of two years. It also provided a feasibility proof as to the level of commitment Aim High youth and their families were willing to make, because parents had to ensure that youth participants would get to the Exploratorium for programs and field trips. Aim High had never asked parents to commit to that level of effort prior to this project, and it worked well.

Prior to the Xtech project, the Exploratorium had a limited relationship with the First Graduate program. For First Graduate, having the opportunity for their students and families to spend time at the Exploratorium was a major benefit. Like Aim High, it also illustrated the commitment students and families were willing to make to participate in long-term programs off-site.

Representatives from both organizations we spoke with indicated that one of the main values of the project was that it provided educational experiences in science and technology for their students that they were not getting from the traditional programs offered through the community organizations. Because of XTech, their students received science and technology-rich programming from one of the premier science learning institutions in the region, complementing the more academic, study-skills, test-prep, and school support activities the community organizations typically provide. The program leaders from Aim High and First Graduate indicated that their students were not getting science- and technology-rich offerings from their schools either:

*Our students typically get textbook instruction in science. The type of science they get through XTech—project-based, hands-on—is a big plus.*

*Most of our kids come from public schools that are under-funded, under-served, and have fairly large class sizes. I think that for a hands-on science curriculum,*

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<sup>10</sup> We discuss this in more detail in the lessons learned section of this report.



*the XTech program takes care of all that is missing, that they wouldn't have access to.*

One youth participant we interviewed confirmed this. When we asked her why she wanted to participate in XTech, she said:

*I thought it would be cool because when I grow up, I want to be a general pediatrician and so I will have to know some of the technology and how things work. I thought it was pretty cool to learn, to do hands-on stuff, because normally at school we don't do that much, like building motors and things.*

These organizations also thought it was beneficial that the XTech project provided opportunities for their students to become fluent tool users. Both representatives thought that the project's emphasis on exposing girls to engineering and tool usage was important:

*Their schools don't have shops anymore either.*

*Here is a situation where we are having some middle school girls that are exposed to much more hands-on activities, and using tools and thinking differently.*

And as we mentioned earlier, these organizations felt that their students and families benefited from the special access and relationship to the Exploratorium that the project provided. In all, the project was highly successful at establishing and solidifying relationships with these key organizations.

## LESSONS LEARNED

Overall, this was a highly successful program, one that provided rich science and technology experiences for youth, provided work and learning experiences for Explainer program graduates, and resulted in mutually beneficial relationships between the Exploratorium and local community based organizations. In this section of the report, we detail the issues and lessons learned from the project.

### *Continuing a Relationship with the Exploratorium*

As we mentioned earlier in this report, youth participants in XTech want to continue a relationship with the Exploratorium, and their parents would like this, too. However, there is a gap between when this program ends and the age at which youth can apply for the High School Explainer program at the museum. Currently, there is no program or capacity, beyond being a visitor, in which former XTech youth can come to the

Exploratorium as part of a structured program. Exploratorium staff members are aware of this issue and, at the time of the graduation ceremonies, were negotiating with staff in charge of the Explainer program to see if younger XTech graduates could be accommodated.<sup>11</sup>

### *Difficulty in Operating a Materials-Intensive Program Off-site*

In the first year of offering XTech programs, Exploratorium staff took materials to the organization sites to work with youth there; however, this ended up being too difficult to continue. This kind of materials-rich programming requires dedicated space, since it is prohibitive to haul computers, tools, and construction materials to off-site locations, where staff have little to no control over their use or the space itself. XTech staff found it better, as did the youth and the community-based organizations, to offer the programming at the Exploratorium. To alleviate a potential complication with transportation, XTech staff provided transportation passes to students. This not only alleviated the materials issue, but also allowed the youth to take advantage of all of the other resources at the Exploratorium, including the exhibits. This special access and relationship to the Exploratorium was mentioned frequently as a major benefit of participating in the project by youth, parents and community organization leaders.

### *Changing Partner Community Organizations*

Another key lesson learned came about through the relationship with the Beacon Center. Originally, the program was going to be offered as part of on-site, after-school drop-in programs at several Beacon Center locations. This created difficulties when there were fewer than anticipated numbers of youth showing up for programming. When the Beacon Center could not guarantee the number of youth and contact hours, the Exploratorium made the difficult decision to end the relationship. They quickly sought work with two community-based organizations that offered more structured programming to meet the required student numbers and contact hours that Exploratorium had proposed to their funders. While the transition time from one community organization to the others was very difficult for all involved, ultimately, the relationships with Aim High and First Graduate ended up being a good fit for the XTech program.

### *Need for Additional Communication with Parents*

A final issue related to communication with the parents of participants. The parents of the youth we interviewed at graduation ceremonies were highly interested in their youths' experiences with the project. While some of them knew a great deal about the

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<sup>11</sup> As of October 2009, Xtech staff were not able to obtain spots on the Explainer crew for Xtech participants; however, they were able to create a smaller Xtech 2 program for approximately 15 of the most interested students from cohort 1 to continue to be involved in programming efforts at the Exploratorium.

experiences their children had in the XTech program, others knew very little because the youth had chosen not to share with them. The project did well at communicating needed information and logistics with the parents, but we wondered if the program would benefit from sharing more about the project's activities, and the accomplishments of the youth beyond the number of hours, with parents along the way.

## SUMMARY

XTech has been a successful program that has provided innovative programming to over 130 youth in the San Francisco Bay Area. The program created mutually beneficial outcomes on several different levels. The first of these was between the Exploratorium and the community organizations providing students to the program. The Exploratorium was able to reach the underserved students from diverse neighborhoods throughout the Bay Area that it wanted to reach through these organizations, while the community organizations' youth received much-needed and much-valued science and technology educational experiences. The second came between the youth participants and the youth facilitators. Participants benefited from the experiences the project provided, as well as from the relationships with the other participants and with the facilitators; the youth facilitators learned valuable teaching and facilitation skills, and made lasting friendships with one another and with the younger participants.

The combination of rigorous hands-on activities, a constructionist philosophy, mentoring, and the stimulating backdrop of the Exploratorium led to powerful experiences for youth participants and facilitators alike. The high adult/staff to student ratio also was a key contributing factor to the success of this program. The XTech project's successes stand as a reminder of the importance of providing underserved youth the opportunity to immerse themselves in a culture of science learning, in a time when opportunities, both in school and out, for youth to learn science and engineering concepts through the construction of personally meaningful artifacts is quite limited.