TEN YEARS OF YOUTH PROGRAMS

AT THE AMERICAN MUSEUM OF NATURAL HISTORY:

AN INDEPENDENT PERSPECTIVE AND LESSONS LEARNED

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January 2008

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OVERVIEW

The American Museum of Natural History (AMNH) in Manhattan is a large, preeminent, well-respected natural history museum. The museum houses vast collections in major scientific areas such as anthropology, paleontology, geology and astrophysics. The museum is also home to hundreds of scientists who conduct research projects all over the world. The museum also conducts dozens of education programs, including long-term, science-rich programs for high school youth from New York City. Since 1992 these youth programs have allowed local, mostly minority, teenagers to participate in two-year programs where they learn about science, the museum, technology, and science research. The teen participants have also had the opportunity to conduct science research with a scientist-mentor. To date, these in-depth programs have served over 200 high school students.

Inverness Research[1] has evaluated informal science education programs, and programs targeting youth, for the past 25 years. During the past ten years, a highlight of our work in the informal field has been our evaluation of three AMNH programs for high school youth.[2] Few other programs in informal science education settings match the duration or intensity of these programs, and few other institutions have had continuous programs over such a long time. Consequently, we felt it was important to portray these programs to a broader audience and to share with that audience the lessons that have emerged from our study of the AMNH efforts.

[1] For more information on Inverness Research, including evaluation reports on AMNH's after-school programs for youth, see our website at www.inverness-research.org.

[2] Over the years, many researchers contributed to Inverness Research's studies of the PSC, ASCEND and ITEST programs at AMNH, including Samantha Broun, Becky Carroll, Kathleen Dickey, Barbara Heenan, Judy Hirabayashi, Miya Hirabayashi, Mary Regan, Laurie Senauke, Anita Smith, Mark St. John, and Felisa Tibbitts.

This Report

In this report, we at Inverness Research share our perspective on ten years of science-rich programming for high school youth at the American Museum of Natural History.

The report includes:

- A discussion of the theory of action and the rationale that underlies the AMNH youth programs
- A description of each of the programs that have been offered and the evolution in program design that has taken place over the years
- A description of the core common features of the programs
- A discussion of the benefits of the programs to youth participants
- An examination of the fundamental challenges that emerge from creating and offering programs for urban high school students in a science-rich institution
- A discussion of some key design features contributing to a successful museum-based youth program

We believe this report will be of interest to funders seeking to support similar youth programs, to science-rich institutions hoping to design and implement such programs, and to a broader audience of people who are interested in finding ways to support the development of minority youth. We also hope that the report will be useful to the American Museum of Natural History itself, as a record of its past accomplishments as well as a guide to future youth programming efforts.

THE THEORY OF ACTION

The three distinct programs we studied developed over a decade at the AMNH. All three stemmed from the same *raison d'être*, and all three shared similar underlying design principles. The major premise behind these programs was that the American Museum of Natural History has a unique set of science and education resources that can be brought to bear in providing programming for youth. These resources include the knowledge and expertise of scientists and science educators, the museum's collections and artifacts, and hundreds of exhibits. Resources also include the working research laboratories, access to cutting-edge technology, and, most importantly, the shared institutional culture of science and science inquiry. The museum reasoned that it could draw on these resources to support cohorts of high school students, particularly those local minority students who do not have the kinds of advantages and resources that better-served youth have. With a well-designed program, these minority youth could be immersed into the rich, intellectual environment of the museum, and

offered a set of challenging experiences that are highly structured and scaffolded.

Following this logic model or theory of action, the museum believed that the benefits to youth from participating in this program could include the acquisition of science content knowledge, skills in using technology, first-hand experience with doing research, and capacity to communicate scientific ideas. In addition, with appropriate supports, minority youth could become immersed in the culture of AMNH – a culture of science, research, rigor and seriousness. Thus, the minority youth would not only learn about science but also develop scientific habits of mind, and in two years of intensive experience, gain overall maturity, responsibility, and confidence.

Within that overarching rationale, there were more specific underlying assumptions. The intention with the AMNH youth programs was for the youth experience not only to be enriching but actually transformative. Youth could change their self images, career interests, and life goals as a result of participating in the program. In order to do that, program leaders sought depth over breadth; the programs were aimed (for the most part) at working with small cohorts for intensive periods of time.

Another underlying assumption was the idea that the AMNH could create a mutually beneficial relationship between minority youth from New York City and the museum staff and resources. Not only would the youth significantly benefit from their participation in the program, but the museum would benefit by becoming smarter about understanding the interests and ideas of young people and thus better at serving the local community. The youth programs help fulfill this part of the museum's outreach mission. The ongoing presence of smart, eager youth also could benefit the education staff and science researchers by adding youthful enthusiasm to the day-to-day workings of the institution. Moreover, through the design, implementation, evaluation and revision of the youth programs over many years, the institution has the opportunity to engage in a long-term learning process about how best to support local minority youth.

Over the past ten years the AMNH not only implemented successful youth programs but they also have come to discover key design principles that can be applied more broadly. From the outset, AMNH wanted to learn from its own programming efforts and ultimately create a model that was not unique to AMNH, but rather could be replicable and extended to other informal science institutions.

THE PROGRAMS

Many different private foundations and public agencies have provided funds to support the three different youth programs at AMNH that we studied over the past ten years. Although supported by different funders, these three programs

were similar in many ways and they evolved along the way. In this section, we describe the three programs in chronological order.

The Precollege Science Collaborative (PSC) Program

In 1992, AMNH received funds from the Howard Hughes Medical Institute's Precollege Science Education Initiative for Science Museums to start the Precollege Science Collaborative (PSC) program for minority high school students at the museum. The PSC program at AMNH was also funded by the Altman Foundation, the Hebrew Technical Institute, and the Helena Rubinstein Foundation.

The program was designed to bring small groups of minority students in their junior year of high school to the museum for two years. During that two-year period, the students spent a minimum of 10 hours per week at the museum, mostly in after-school hours. They learned about the museum and science research and carried out a research project alongside a scientist-mentor. Youth selected a question to research from a wide range of possible topics, the only limiting factor being that of available scientist-mentors to work with the students. The research took place either at the AMNH or at other institutions in New York City, such as Columbia University. As part of the program, students participated in special outings, including overnight camping trips, and attended lectures by scientists. Students also presented findings from their research to museum staff, scientists and family members.

The co-creators of this program were Ismael Calderon, who worked at the AMNH in the department of education in the early 1990s, and Dr. O.R. Anderson from Columbia University. Their goals were clear: to help underrepresented and minority youth be more science-research and college oriented. The key program features were to provide small groups of students with an opportunity to do real science research, connect with scientists, and have the tools and technology skills they needed to be successful in college and future research careers.

This program ran from 1992-2002 and served 74 students in nine cohorts. Inverness Research studied the program in 1998, assessing the program through program observations; interviews with and surveys of youth; and interviews with staff, scientist-mentors and parents. In addition, Inverness did longer-term studies of the PSC graduates, talking with them shortly after they graduated and five years later.

Based on the success of the PSC program, and in an effort to involve more youth in after-school programs, in 2001, AMNH staff designed the High School Science Research Program (HSSRP). The HSSRP is a collection of programs funded by local, state and national funders. The program involves four areas of science research: genetics, astrophysics, biodiversity and anthropology. Hundreds of youth participate in HSSRP summer institutes, then choose from a series of

after-school courses the following year. The following two programs that we studied have also been part of the HSSRP.

The After School Center for Explorations and New Discoveries (ASCEND) Program

The next evolution in youth programs at AMNH was the After School Center for Explorations and New Discoveries (ASCEND) program. Funded by the National Science Foundation and the Lita Annenberg Hazen Foundation, this program began in 2002 and offered after-school experiences to high school students in the fields of genetics, genomics and genethics. A total of 52 students in three separate cohorts were served through the ASCEND program from 2002-2006. Students were selected after participating in an HSSRP summer institute and were chosen based on their interest in genetics and available openings in the program. The majority of participants were female youth of color. Similar to the PSC program, in the first year youth participated in courses, lab work, and group projects two days a week. Topics they covered included laboratory procedures and safety, DNA cloning and amplification, DNA sequencing and microarray, and bioinformatics. During the second year, youth participated in independent research with scientist-mentors at the museum or collaborating institutions such as Rockefeller University, the Wildlife Conservation Society, and the Sloan Kettering Institute. Also in the second year, the students met monthly as a group with the program leader to discuss current topics in genetics, share progress on their research, investigate possible careers, and prepare for their final presentations. Students also received extensive SAT test preparation and went on occasional field trips.

Inverness Research conducted a summative evaluation of the ASCEND program in 2004-2005. We observed classes, special events and the graduation ceremony of the second cohort; interviewed and conducted focus groups with participating students; interviewed scientist-mentors; and conducted formal and informal interviews with parents and family members.

The ITEST High School Science Research Program

The current iteration of after-school programs for youth at AMNH is the ITEST High School Science Research Program. Funded in 2005 through a National Science Foundation Information Technology Experiences for Students and Teachers (ITEST) grant, this program targets 120 urban high school youth, grades 10-12. The program provides two years of immersion in information technology-based research in genetics and astrophysics. The program involves cohort groups of approximately 40-50 students per year. Students learn to use advanced information technology in conducting their own authentic scientific research. In the first year, participants attend a one or two week session each summer, and then attend a series of classes at the museum four-to-six hours per week throughout the school year. In their second year they focus on a particular

research project working closely with scientists and graduate student mentors, and must prepare a scientific research report. Special guest speakers, field trips, college fairs and SAT preparation support also take place throughout the two-year program.

Inverness Research is currently conducting an evaluation of the AMNH ITEST program. The evaluation has included program observations; pre- and post-program surveys of participants; as well as interviews and focus groups with students, parents and scientists. In addition, we have conducted interviews and surveys with "case students" whose experiences we are documenting in depth, and attended special events and the first cohort's graduation. As part of this evaluation, we also interviewed several graduates of the PSC program, and conducted a brief scan of the field for similar youth programs.

Core Design Features of the Programs

Although the three programs described in the previous section have slight differences among them, as we have already noted, they share many core features which we will describe below. We believe it is these common features that contributed to the overall program benefits to youth.

The programs are challenging

The first core feature is that these programs are challenging in multiple ways. First, the weekly and yearly time commitment is great – students must often choose between participating in an AMNH after-school program and other activities, such as sports. Second, the academic work, scientific papers and research that is required of participants is difficult, demanding above-average time and effort. In addition, because much of the second year research work is done independently, students have to be able to conduct scientifically-sound research with minimal supervision, and manage their time and responsibilities well.

The programs are scientifically rigorous

One of the hallmark features of these programs is the rigorous science content that the students encounter, both in the first year as they learn about potential research topics and in the second year as they actually work on their research projects. For example, in the current ITEST program, students in the astrophysics section have studied black body radiation, a topic normally studied by astrophysics majors in the later years of college. In genetics, students learn about DNA sequencing and polymerase chain reactions. The research projects that students have worked on over the years are very diverse, representing the range of interests of the students and the expertise and resources of AMNH. A

small sample of projects conducted by students in the programs over the years includes studies of:

- chlorine in the water in Central Park
- chimpanzee brains
- the effects of Prozac on plants
- the molar absorptivity levels in trachvandesite glasses
- the social behavior of Przewalski's horses
- the remains of Native Indians from Mexico
- calculation of the rotational curve of the Milky Way Galaxy using the Museum's 21-cm radio telescope
- the identification of black holes using data from the Chandra X-Ray Observatory
- endocasts of extant and fossilized penguins
- morphological diversity in cichlids from African rivers and lakes
- the phylogeny of southeast Asian flying foxes and their ectoparasites

The programs are technology-rich

The integration of technology into the activities has always been a core feature of the programs. In the PSC program, for example, when the cohorts were smaller, each student received a laptop which they used throughout the program to enter and analyze data and prepare their presentations. They took these laptops with them to college. Students in all three programs have also been exposed to cutting-edge technologies in both the study and research sections, including electron microscopes, gel electrophoresis, equipment that helps scientists sequence DNA, astronomical data sets from external sources such as the Sloan Digital Sky Survey, and other sophisticated lab equipment.

The programs involve students moving from study to research experiences with a scientist-mentor

Another core feature is that students progress from studying current science topics and how to do scientific research in year one to conducting independent research projects in year two. The year-one experiences have included explorations of the museum, group discussions on current science topics, guest speakers, and inquiry activities. In year two of the programs, students are paired with a scientist-mentor with whom they work on independent research projects. Thus, students learn such steps in the research process as scientific observation, data collection and analysis, and the preparation of scientific papers, including the drafting of abstracts and detailed bibliographies.

The programs are overseen and conducted by a key staff person who serves as a liaison between youth and the museum

The program leader has been a key component in all of the programs. This scientist-educator serves as the liaison between the youth and the museum.

This person provides the introductory learning experiences in year one and introduces the youth to the museum. In addition, the program leader helps introduce students to the range of research experiences available to them and helps them find a mentor. As they engage in their own research, the students rely on the program leader to help them analyze data and prepare their reports and presentations. Throughout, the program leader is the key adult support person, both intellectually and emotionally.

The programs involve small cohorts of youth who are well-supported

The cohorts that move on to the research component have been deliberately kept small (from 9-20 students). Small numbers in each cohort make it more feasible to find scientist-mentors well matched to the youth, and make it more likely that the students can be adequately supported in the research phase of the program.

Smaller numbers also enable other kinds of support to be provided more effectively. Cohorts have been provided support through such things as SAT preparation, outside field trips, and college and career preparation. These supports help broaden the youth's perspectives about the opportunities available to them in science and research, as well as make college and science careers more of a possibility. The programs, and all of the associated supports, have always been provided free of cost to the students who participate. In addition, students generally receive stipends to cover the cost of transportation to and from the museum.

The programs include mechanisms for building students' communication skills

Another key feature of the programs over the years has been the emphasis on students' gaining skills and practice in communicating their research. In year one of the programs, students are asked to summarize newspaper and journal articles on scientific research and share those with their peers. Students in all programs have always been required to prepare a presentation about their research findings; this has usually included a rigorous scientific paper, posters, and an oral presentation.

The programs take advantage of the museum's unique resources

In addition to drawing on the considerable expertise of scientists at the AMNH, the programs also provide numerous opportunities for students to interact with the museum's unique collections, exhibits, and labs. Students visit halls and exhibits such as the Spitzer Hall of Human Origins, view the night sky through the Zeiss projector of the Hayden Planetarium, attend the museum's Space Show, and visit the Sackler Institute for Comparative Genomics and the AMNH

cryo-collections to view tissue samples of thousands of organisms in vats of liquid nitrogen.

The programs involve the students' parents and families

The programs have sought the involvement and support of parents and family members. There have been opportunities for parents to learn about the program and the available resources, through open houses and family breakfasts. In addition, the parents and family members have always been invited to attend the graduation ceremonies to hear the students' final research presentations.

OVERALL BENEFITS TO PARTICIPANTS

The AMNH programs for high school youth were intended to impact the lives of the youth who participated in them. In our studies of these programs over the years, we have found consistent and significant benefits to youth participants. We have seen these benefits both in the short-term, as explained by those students participating in the program at the time we interviewed them, and in the long-term, as explained by graduates of the programs that we spoke with two to five years later.

Increased confidence and expansion of potential

An increase in confidence is perhaps one of the greatest benefits reported to us by participants, both past and present. Learning how to master rigorous science content, how to work with a new group of peers, how to work independently on scientific research in unfamiliar lab settings, and how to present scientific findings in a formal setting – all of these build confidence and help youth believe that they can handle anything.

Youth gain invaluable problem-solving skills and confidence, primarily as they work on their research projects in the laboratories. Oftentimes, their scientist-mentor is not with them full-time; when students hit a snag, they have to be able to figure out how to work through problems and make sure their data is correct and accurate.

All of this leads youth to an expanded idea of what they can do and accomplish. This quote[3] from a PSC graduate[4] who was reflecting back on the program illustrates how the rigor of the program increased his feelings of self-worth:

[3] The quotes have been lightly edited for clarity. We have chosen a select number of quotes from ten years of available data; the quotes included here are highly representative of the experiences of many youth from these programs.

[4] The term "graduate" refers to those students who were interviewed or responded to surveys after they had graduated from the program; these graduates were interviewed and/or surveyed anywhere from two to five years past graduation. The term "participant" refers to those students whom we interviewed or surveyed at the time of their participation in the program.

The sense that I accomplished something… The program is two years, it is very time-consuming and tedious sometimes. But I stayed with it. It showed me I did something worthwhile. (PSC graduate)

Perhaps most importantly, the programs, targeting minority youth who have few opportunities for rich science experiences in other parts of their lives, foster in youth a spirit of intellectualism. This is highly significant, particularly for young women and minorities who in other parts of their lives might be made to feel as if their intelligence should be downplayed. This quote from a female minority student illustrates the important role the ASCEND program played in her discovery and celebration of her intelligence:

I am comfy being smart. I embody what a smart person or scientist is, and I am not afraid to come out and voice my opinions and talk about why I know what I know and what I have done. (ASCEND participant)

An important part of participants embracing their intelligence stems from the program creating an alternate, science-oriented peer group for youth. Youth benefited from working with other students from throughout the New York City area. These youth programs created an alternate peer group to the ones they had at their schools; the museum peer group was organized around and driven by science. One female PSC graduate spoke of the importance of youth role models in the program:

People in my high school, a lot of them were dropping out, weren't graduating. So I didn't look at what they did. I looked at what my friends in the PSC program were doing. (PSC graduate)

Re-conceptualization with regard to career and professional life

Another related and significant benefit of participating in these programs for youth has been gaining a greater awareness of what it takes to be a scientist. In many cases, the programs help students realize that being a scientist is what they want to do; others learn that science and scientific research are not right for them. One participant's words reflect the sentiments of many youth from these programs:

It [ASCEND] definitely is what solidified the fact that this [science] is what I want to do. I'd like to do research in genetics and biology. That was the biggest thing I got out of this program. (ASCEND participant)

The graduates of these programs we interviewed most recently were all pursuing careers that were informed by their participation in the AMNH's programs. Some were in medical school studying to be doctors; one was studying neurobiology;

and others were pursuing museum, mathematics and bilingual education degrees.

One participant from the ITEST program commented on how important it had been to her to see herself situated in a lab within the scientific community:

> *[The most important thing for me was] learning to work in a scientific environment, and seeing how I would fit into a scientific community when I have a career. I actually want a career in paleontology and so working in the paleontology department of the Museum of Natural History is a really good step to getting some of the experience and just getting a general feel for the workplace… and seeing what I will be doing in ten years. (ITEST participant)*

Acculturation into a formal science environment

A major part of this re-conceptualizing of one's self in relation to science and science careers comes about during the research portion of the program. Participants found their first days in the labs to be somewhat overwhelming experiences. They were not sure what to expect or how they would fit in. They wondered if they would be the only minority faces they saw in the labs. Learning how to acclimate to the labs, to fit in and thrive in a very new and unfamiliar setting, was an important point of honor for participants.

One PSC graduate explained how influential her time in the lab had been in terms of her decision to pursue science as a career:

> *That first glimpse of being in the lab and seeing what bench work is all about, that was an incredible experience. That is one of those things that really helps you understand if you want to do this… As an African-American woman, it was not a typical experience. It had a real impact on how and if I could do research. (PSC graduate)*

This lab experience not only turned out to be beneficial to students at the time, but also was important to participants years later. Several PSC graduates we interviewed spoke of how invaluable the experience of learning how to fit into these labs had been. One PSC graduate explained:

> *The whole fact that [in the PSC program] I had to look for my own mentor. . . . Initially we were all complaining about approaching doctors and how to ask them. Oddly enough, that follows through everywhere. You have to put your foot in the door and make opportunities for yourself. This is exactly what I have to do right now in grad school – find mentors for my dissertation. I had to go introduce myself and explain that I was interested in this science and could I do a rotation? It almost parallels what I had to do in the PSC program. (PSC graduate)*

Improved study skills and work habits

An improved work ethic was another benefit frequently mentioned by participants from all three programs as well as their parents. Participants had to juggle the rigors of the program with the demands of school and home life. They learned how to utilize their precious time well. One PSC graduate spoke of how dealing with the requirements of the program had helped later in life:

> *Setting a schedule and committing yourself to certain days and seeing it through, I think prepared all of us for college. I think if I went directly from high school to college, without coming through this program, I probably would have had a hard time adjusting. But because I had the two years' experience, I knew what to do. My mind was already set on certain things. This has helped me out a lot, even in my job today. (PSC graduate)*

It is interesting to note that parents of participants we interviewed and surveyed over the years often commented on how much more focused their children became as a result of participating in this program.

> *Our son has become very focused about what he wants and what area he wants to work in in the future. In other words, he has selected his goals of the future while working at AMNH. (Parent of ITEST participant)*

Science content

One of the driving forces behind the programs is the assumption that students, and in particular, minority high school students, do not have access to rigorous science content, even in their schools. Thus, great attention has been paid by the project to this facet of the program.

The students we interviewed over the years have clearly benefited from learning the rigorous science content. Many participants spoke of learning a level of science they would never have thought possible and how the science in the program is more meaningful, challenging, and fun than what they learn in school. As one ITEST participant noted, learning the content means getting to ask questions, something that is rare at school:

> *When you come here, you get to ask a lot of questions… ask the questions you can't ask at school. (ITEST participant)*

In addition, graduates we interviewed spoke of how much of what they experienced in their college courses was easy in comparison to what they experienced through the AMNH's programs. One ASCEND graduate spoke of

the “leg up” he had in college because entry-level science courses that ordinarily would have been difficult were not so challenging.

> *It was a real stepping stone for me. I think I probably wouldn’t have done as well in my college classes had I not had the background [from ASCEND] to fall back on. (ASCEND graduate)*

Communication and technology skills

The program provides many opportunities for students to improve communication skills. One way is through synthesizing and sharing current science topics with each other. Perhaps most importantly, the presentations of research findings youth give at the end of year two result in the acquisition of many communication skills. One PSC graduate spoke of learning how to talk about science and communicating the complex ideas of science to others, much as real scientists do:

> *In my major, I have to present a lot of research-based science material in front of an audience. The PSC program was a stepping stone for me to get used to such situations. The PSC program enhanced my ability to represent my projects, communicate effectively and have confidence when I am speaking. (PSC graduate)*

In addition, youth are exposed in the program to the most cutting-edge technologies, from computers to expensive laboratory equipment. Not only do students learn from being engaged in authentic science research, but they benefit from using the latest in technological equipment. The tools they use in this program are not ones typically found in high school science laboratories. It is important to note that in this program, the technology learning is always in service of the scientific research that is being conducted, as one ITEST participant explained:

> *We are working with CT scanners and usually CT scans are used for the medical field. I thought it was interesting how… the CT scanner could penetrate through whatever substance and do scans of the bone material and also the interior structure. I thought it was interesting how they could incorporate that with paleontology – like bringing modern technology to ancient bones and fossils. (ITEST participant)*

STUDENT EXPERIENCE VIGNETTE

The student described in this vignette is an 11th grader who began participating in the Hayden Astrophysics program, part of the AMNH-ITEST program, when she was in 7th grade. Her parents are immigrants from Mexico and she describes her neighborhood as a place where there are not a lot of opportunities or good examples for young people. Before she began the program she was interested in social studies and improving her English and had thought of becoming a teacher or a lawyer. Her middle school offered few opportunities to study science and for this reason she signed up for the program at AMNH. After a few years in the program, she realized that she really enjoyed math and science and chose a high school that emphasizes math and science. After her last two years in the astrophysics branch of ITEST, she now thinks she may want to pursue a different career.

> *I remember I wanted to be a teacher, or a lawyer, but now that I am into this, maybe I will pursue a career in astrophysics or astronomy. What we are doing right now, it is like more real time, like an astrophysicist, we are using IDL [computer program] as if we were really, really astrophysicists. It is really interesting… Maybe there is a chance I might go into that field.*

She describes the time and attention given to her by the museum staff, including her research mentor, and explains that she learns well at the museum because of the efforts of the staff to ensure she thoroughly understands the material.

> *You can't stop unless you solve the problem. Otherwise, our teachers will send you to think about it, to ask questions. They always tell us "If you don't get something, ask questions, ask questions, that is the way to learn."*

As a result, she has gone from not knowing about astrophysics to being able to describe complex theories, analyze data from satellites and help install a radio telescope. She describes the impact this learning has had on her experience at school.

> *I was in the 9th grade and we were already learning about Planck's constant [at the museum] and this year [11th grade] in my physics class the teacher talked about it, and I actually knew what he was talking about. I saw other people around me struggling. I had an idea of what it was, so it was a bit easier for me to understand it. Also, the teacher will talk about supernovas or something and he will ask the class if somebody knows about them and he is surprised that I know the answer. He actually asked me, "How come you know all of this?" I told him I was in a program and he was really shocked, he said "Oh wow. I can't believe there are still students out there that do such things." The feeling of it is wonderful.*

She describes these benefits extending beyond physics to her computer programming and math classes where skills and knowledge she learned at the museum transfer into her work in these classes. She knows these will give her an advantage when she enters college. Beyond the obvious impact on her math and science capacities, the experiences she's had at the museum have given this student great confidence in her abilities and a sense of pride in her accomplishments.

> *It gives you this feeling that you are not down there where everybody expects, especially for me, a Hispanic person coming from immigrant parents. They expect me to drop out of high school, because that is what a lot of people are doing, they are dropping out and getting pregnant. Just the fact that you are up there and to know that you can make it out there.*

Her parents have supported and encouraged her participation in the program and share her sense of pride. Her younger brother is now in the program and she gave him the following advice.

> *At first it is kind of hard because they teach you all of this hard stuff and you think, "I can't do this, I can't do this, it is too much for me, I am not ready for this." But as time passes by, you realize that you are capable, and that is one of the things that this program helps you with a lot, realizing that you are capable of doing something and succeeding. If there is an obstacle and if there is a problem that you can't solve, there is a way for you to get the answer.*

She summarized her experience by saying:

> *It has been amazing. A life-changing experience. I feel like I am somebody.*

ISSUES AND CHALLENGES

Running in-depth, long-term education programs for minority youth in a very large science institution is not without challenges. Over the course of the last ten years, we have consistently seen several challenges emerge. We have organized our discussion around some of the central, commonly held questions the developers and program leaders at the AMNH confronted through the course of their work.

- ***Should the program serve only a small number of students working with them very intensively, or should it serve larger numbers and work with them less intensively?***

Perhaps the greatest challenge museums face in designing and delivering programs for youth centers on the number of participants they can serve well. Funders in many instances look for higher numbers of students served as one of the signs of success. Programs face questions such as, how do you simultaneously design a program that is truly transformational for participants and serves many students? Is there a balance that allows for many students to have a less intensive experience while still allowing a small number to have the more-intense, rigorous research experience?

When the program first began at AMNH, the emphasis was definitely on depth – the PSC program worked with 10 or fewer students per cohort in a highly-customized, highly supportive environment. Our interviews with participants in and graduates of the PSC program offer very strong evidence that this program was truly "transformational" for these students. Over the years, the project expanded to where now, in the HSSRP, the first year of the program serves hundreds of students through after-school courses in various topics, then provides the research experience to up to 20 students in the second year. For those students who do not have the more intensive experience, the program is one that enriches but, in our estimation, probably does not transform their lives. In addition, the increase in participants in the research year, in part, has led to pairs of students working in partnership on their research projects in the latest iteration of the program. While there are still benefits to this approach, we also know that the benefits of the one-on-one mentorships that are closely tied to students' interests were profound.

From our perspective, serving fewer students in a more intensive fashion leads to experiences that are truly life-changing for the participants.

- ***How can minority youth be successfully integrated into a large institution?***

One of the most profound challenges is figuring out how to interface urban youth with the museum so that, over time, they become successfully integrated into the institution. Bringing minority and underserved youth into a large institution without them being marginalized is difficult. Because the programs at AMNH have involved youth interacting with a few scientists within a few departments over time, there has been a profound impact on the youth who have participated. It has been more difficult, however, for the youth to have had a profound impact on the institution, in part, because the youth programs are only a small piece of the overall museum's work. In addition, turnover at both the program leadership level and in the larger education department has limited the extent to which the museum has been able to reflect on, study and learn from its own efforts.

- ***How "school-like" should a voluntary after-school program be?***

Another challenge comes in creating experiences for high school aged youth in an after-school setting that are not too school-like. The after-school programs at AMNH are rigorous, yet voluntary. Program leaders must walk a fine line between keeping things rigorous in terms of the content, responsibilities and requirements, without it being too much like traditional schooling.

In our observations over the years, we have seen times when the tone, activities, and approach of the programs are too reminiscent of typical high school class settings, characterized by such icons as quizzes and teacher monologues. From our perspective the programs are most successful when fostering an atmosphere of mutual respect, student creativity and curiosity, and shared scientific inquiry.

- ***Should students only be placed for their research assignments within AMNH, or should the museum also utilize other local, science-rich institutions?***

In the early days of the program, the research projects were, for the most part, driven by the interests of the youth. Because the numbers of students were small, students could be paired up with scientists at AMNH, and program leaders also looked outside of AMNH if the student was interested in an area where a suitable mentor could not be found within the museum. This program was, therefore, driven more by the interests and needs of the students than the available resources of the museum.

Over the years, education department leadership felt that the program should focus more on in-house expertise and resources. This led to the specialization of the program into several distinct areas: genetics, astrophysics, biodiversity and anthropology – areas where the museum had substantial collections and human resources to draw on. We think that utilizing the museum's resources first and foremost makes sense given the wealth of people and material at hand, as long as the research is of interest to the students and there are enough mentors for meaningful research experiences for students.

- ***Should the key program leader be first and foremost a scientist or an educator?***

Another design tension comes in bridging the gap between the scientists and the youth. Instructors in the program are dealing with very high-level science content and need to know that well. In addition, they are dealing with adolescents in an after-school setting, which also requires special expertise. These program leaders have to have considerable science content knowledge, but also considerable knowledge and rapport with minority youth. They also have to know the institution and the scientist-mentors so that they can bridge the needs of the scientists with the needs of the youth and program.

The programs have gone back and forth over the years in terms of how much science expertise the program leadership has versus how much education expertise. We think having a program leader who is a scientist can work well, as long as the museum provides enough key support and professional development so that the students are not only learning science content, but are also nurtured in the program. Conversely, having a lead person who is more of an educator can also work well, as long as that person has sufficient support and structure to draw on the plentiful scientific resources of the museum.

- ***How can long-term funding be secured so that programs for youth are institutionalized?***

Another challenge comes in finding long-term funding for these programs. The AMNH has found funding for these youth programs from a variety of sources, but each funder brings their own set of agendas and requirements. Finding funding that matches the goals of the program and the needs of the institution, so that this program remains the museum's program and not the funders' program, is crucial.

LESSONS LEARNED

In this section of the report, we summarize some of the lessons learned from the past ten years of studying the programs at AMNH. In many cases, participating in this program was transformational for youth. In others, the program served as a good educational enrichment experience. Here we offer our perspectives on the program elements that made the difference for youth between good enrichment and those experiences that were truly transformational.

Stewardship

The person who works directly with the youth and who interfaces for the program between the youth and the museum is profoundly important to the success of the

program and of the students who participate in it. Having a nurturer in this position is vital. For the program to be a success, this person must be someone who can nurture not only the program within the museum but the youth within the program. This person must serve as a role model, listener and advocate for the youth, and understand the needs of the scientist-mentors to make the most productive matches. Perhaps most importantly, this person must tirelessly hold the vision for the program within the larger institution.

Careful matching up of scientist-mentor to student

In the best cases, scientists and students formed important bonds during the research year. In a few of these best cases, students were involved in the writing of the scientists' research papers that were published in journals, or accompanied the scientists on trips to gather research. Mentors benefited from having students assist them with their research and from having ongoing, positive relationships with highly-motivated high school students, a rare opportunity for them. In the worst cases, youth and mentors simply could not bond, and students had to seek out new mentors. In other cases, the research tasks the students were engaged in were not meaningful to the students or highly relevant to the research of the scientists, but were rather tasks the scientists had come up with to keep the students occupied.

Careful recruitment, selection of and support for the mentors

A key challenge is how to recruit and adequately prepare mentors for working with the youth. It has always been difficult for program leaders to find enough mentors. Departments often don't make working with teens a departmental priority, so even those scientists who are interested have to carve out time amidst more pressing demands. And even those who are interested have often not received enough preparation about the goals of the program, and more importantly, the maturity level of the youth and how to set expectations that will work for all sides. For these types of mentorships to be the most effective, mentors need to be carefully recruited, expectations on both sides need to be clear and frequently communicated, and mentors need to be offered ongoing training and support.

Support and structure for program staff

Because the work of the program leader is so crucial to the success of the program, program leaders need to be supported within the larger institution. These educators need to have a structure by which they themselves can reflect on their program and practice, on their relationship with the students and mentors, and on the program as a whole. They need to be evaluated and offered professional development that can assist them in drawing on their strengths and improving areas of weakness.

SUMMARY

The programs for high-school aged youth at AMNH over the years have created a mutually beneficial relationship for both the youth and the museum. The youth clearly benefit in meaningful and powerful ways. Many, many youth over the years have indeed been transformed by their experiences in these programs; the programs laid an important foundation for their college and later careers in science and education. Although less realized, the museum also benefited from these programs. Not only have the programs helped the museum fulfill its outreach mission, but they have also provided individual learning opportunities for many educators and scientists.

The AMNH youth programs show that it is possible to draw upon the assets of a science-rich institution and make them available to under-represented high-school aged youth. Over the years the museum has learned how to design opportunities that can utilize the museum's assets to explore science and science research in great depth. The museum has provided supports and structures that have engaged youth in authentic research tasks, alongside real, working scientists as their mentors.

As we stated at the beginning of this report, we have found this type of program for high-school aged youth in museums to be a good investment for foundations. The investment helps to develop programs that meet numerous goals: serving minority youth; promoting science, technology and mathematics education in urban environments; creating accessible and effective informal science enrichment opportunities; and empowering cultural institutions to take on meaningful roles in the community. This type of program may well be an investment for other funders to consider because of the longitudinal evidence we have gathered that it is a powerful program for its participants.

We believe that there is untapped potential in other science-rich educational institutions to offer this type of programming. Currently, few other institutions offer programs that match the duration or intensity of these AMNH offerings. The lessons learned from studying the AMNH after-school programs for high school youth provide an important model for others who might be interested in serving their local communities in similar ways.