ALL IN THE FAMILY

Science museums and centers around the country are discovering innovative ways to inspire students' interest in STEM subjects — including getting the whole family involved in exploring the wonders of science.

By **Aruna D'Souza**

Science Smarts The American Museum of Natural History in New York City has been a leader in developing school and community engagement programs in the largest public school system in the country — including Urban Advantage, which allows middle school students and their teachers and families to take advantage of the educational resources on offer at science-rich cultural institutions around NYC. PHOTO: EMMANUEL DUNAND/AFP/GETTY IMAGES

How do kids learn best? That perennial question gained new traction after President Barack Obama's 2011 State of the Union address, in which he called for a sharper focus by America's education system on science, technology, engineering, and mathematics (STEM) in order to prepare students for the challenges facing the nation and the world in the coming decades. His call has led to large-scale attempts to transform education in the United States. These include ambitious projects like 100Kin10, an initiative that aims to recruit and develop 100,000 excellent teachers in STEM fields by the year 2021, and the development of the Next Generation Science Standards (NGSS), a new vision for K–12 science education that integrates science and engineering practices with disciplining core ideas and crosscutting concepts in science.

But for all the focus on what happens in the classroom, education leaders are increasingly aware that children learn in a complex ecosystem that extends well beyond formal educational settings. Science and natural history museums, zoos, botanical gardens, and other types of science centers increasingly position themselves as important contributors to children's overall science education, as spaces of informal learning that can deepen and extend what schools and families have to offer. This is especially the case as more states and individual school districts around the country adopt Next Generation Science Standards, which emphasize hands-on, experiential learning driven by students investigating science phenomena and designing solutions to problems — a sweet spot for science centers and museums, which have long emphasized this type of engagement. Fortunately, these types of institutions also have a degree of freedom to think creatively about how best to spark students' curiosity. As a result, many science museums and centers around the country are working to help develop classroom resources and bolster professional learning opportunities for science teachers in their communities, and to otherwise support overburdened public school systems.

At the same time, education leaders are paying new attention to an old truth: that kids do better in school when their families and communities are involved in their education. This renewed interest in family engagement may be the result of a hard-won lesson of recent years — namely, the widespread resistance to the Common Core educational standards, a backlash largely attributed to the failure to involve families in the process of overhauling the K–12 curriculum nationwide. It is based, too, on well-established research that shows the importance of families in a child's learning ecosystem, especially for kids from immigrant and low-income families.

Only Connect! At the New York Hall of Science in Corona, Queens, kids delight in *Connected Worlds*, an exhibition created by Design I/O that uses cutting-edge interactive technology to demonstrate the feedback loops that shape our ecosystem. The experience is driven by kids' own curiosity: by manipulating water sources in any of six virtual biomes, they can see the effects on the other connected environments. PHOTO: DAVID HANDSCHUH AND DESIGN I/O

These insights have spurred major funding organizations, including Carnegie Corporation of New York, to explore ways to connect with parents and communities beyond school settings, as a way to spur students' success. "As Carnegie Corporation's strategy to engage parents as key stakeholders in their children's education evolved, we began looking for the greatest points of influence and most effective strategies to reach families and communities at a local level — in short, how to reach parents where they are," explains Ambika Kapur, a program officer in education.

Consequently, with the support of Carnegie Corporation of New York and other grantmaking bodies, some of the leading science centers and museums around the country are developing a "two-generation approach" to science education that emphasizes teaching parents at the same time as teaching kids. Here's how some of these institutions are increasing their focus on families.

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Creating Science Superheroes

When asked to give an example of how the New York Hall of Science (NYSCI) measures its success at engaging visitors, president and CEO Margaret Honey recalls one young child's feedback about his visit: "This exhibit makes me feel like a superhero!"

Much of NYSCI's work with its community in Corona involves just this kind of empowerment — making kids and their families feel like STEM concepts are within their grasp. The museum's Queens neighborhood is notable for its high proportion of immigrant families: two-thirds of households are first-generation immigrants, largely from rural communities in Central and South America. Many are undocumented, and most are what sociologists term "working poor" — meaning parents often hold multiple, low-paid jobs to make ends meet. The community is deeply aspirational. Many residents came to the U.S. in difficult circumstances with the sole purpose of giving their children opportunities they would never have in their home countries.

NYSCI is, for many of its visitors, their first museum experience ever. Honey is acutely aware of this fact, as she is of the barriers that the museum must break down in order to make everyone feel welcome — starting, quite literally, at the front door. "In a community where many are undocumented, staring at a building with what we think of as big, beautiful, fascinating NASA rockets outside, can actually be very intimidating. To them, it indicates something quite different — the presence of the government."

To get the families in Corona engaged, convincing them to walk past those rockets is crucial. "Part of our thinking about the two-generation approach to STEM learning has to do with building trust," Honey explains. "Parents need to feel that the museum is a safe and welcoming environment, they need to know there are people here who can converse with them in their native language, and who will make them feel at home and make them feel comfortable. Because many parents in the community are only conversant in their native language, largely Spanish, they rely on their children to do a lot of interpretive work for them, too. When it comes to education, the more we can build experiences and create opportunities for parents and children doing things together, the more effective our work can be."

With this in mind, NYSCI has developed a number of innovative approaches to involve parents in their children's exposure to STEM, and to help them develop a vocabulary that allows them to be more actively involved in their kids' education both inside and outside the classroom. This means, in effect, educating parents while educating the child — whether by offering free or discounted entry to about 700 local families through its Neighbors program, running activities designed specifically for parent-child engagement, or working with parent coordinators who are embedded in local schools to act as liaisons with families trying to navigate the New York public school system. STEM nights offer an opportunity for parents to meet professionals in science-related fields, an important starting point for imagining their own child's potential career path.

A new program called Parent University, being developed with support from Carnegie Corporation of New York, is part of this work. Its goal is to make finding and using resources available at the museum, in the schools, and in

the community easier for parents, and to help them guide their children into STEM learning. The program also aims to help them view NYSCI as a community hub where children, their caregivers, and their teachers can dive into creative learning opportunities.

The museum hopes that Parent University will put families in the driver's seat, turning them into effective advocates when it comes to their children's exposure to STEM. "We're moving away from the position of expert and more into the position of facilitator," says Honey. "It's a way of being responsive to the organic way in which our families work, in which children are central to the process of navigating the world. It helps everybody find their voice in a place that may feel very unfamiliar to them."

Scalable Results

The American Museum of Natural History (AMNH) is one of the most visited science museums in the nation, with an audience that spans the globe. But it is very much part of its community, too: the five boroughs that make up the City of New York — some 8.5 million residents and the largest public school district in the nation, serving 1.1 million students representing a breathtaking diversity.

AMNH has long been a leader in developing community partnerships and large-scale approaches to augmenting and extending formal educational opportunities for students in New York. It was a leader in developing the Urban Advantage (UA) program 14 years ago. Funded by the New York City Council and the New York City Department of Education (DOE), Urban Advantage has so far reached approximately 450,000 students through multiyear experiences with its programs, and over 2,000 teachers. In partnership with New York City's Department of Education and other science-rich cultural institutions including the New York, Brooklyn, and Queens botanical gardens, the Bronx and Staten Island zoos, the New York Aquarium, and the New York Hall of Science, Urban Advantage teams with public middle schools by offering free entry for students and their families, class trips (including pre-planning opportunities for teachers), paid professional development for teachers, and funds for classroom materials. Perhaps most importantly for parental engagement are the Family Science Days, running throughout the year, and the annual Science Expo, which draws the participation of 900 middle school students. Both events offer important opportunities for parents and caregivers to see what their kids are learning in and out of the classroom.

Since the establishment of New York City's Urban Advantage, similar programs have sprung up in other cities around the country. This is wholly by design — the museum sees its role as an incubator for rethinking what science museums can do and how they can engage the public. This commitment has been at the heart of President Ellen V. Futter's leadership of AMNH. "Ellen really challenged us to think deeply about the assets of the institution, and the impact we could have at a social scale, as well as an individual scale," says Lisa Gugenheim, senior vice president for institutional advancement, strategic planning, and education. "One feature of the institution is that it's grounded in New York City, with the largest school system in the country. We have some confidence that if a model can be robust in New York given the economic diversity, the language diversity, the transportation and geographic issues, and so on, then we can share that work very broadly and very openly. That's been the case across our programs, whether it's family programs or teacher development programs."

For AMNH, the takeaway from Urban Advantage has been that science centers and museums can have tangible results when it comes to success in STEM education — a finding that has led to a shift in how such institutions conceive their roles in relation to formal education of K–12 students. "The research has taken us to ask how young people involved in the UA program are doing on intermediate science exams," explains Gugenheim, "and lo and behold we discovered they're doing better. That was a major finding for the museum community, because I think the idea for so long was that museums were seen as a place of inspiration and of beauty for schoolchildren, but not necessarily as a partner that could support academic outcomes. It also pushed us to see our work in terms of accountability — we started to think about what these third spaces can offer in terms of the larger education ecosystem."

Feedback Loops

One of the cities that adapted the Urban Advantage model is Denver. The Denver Museum of Nature & Science, the Denver Zoo, and the Denver Botanical Gardens have partnered with the city's public school district to expand educational opportunities for students. The decision was prompted at least in part by sheer need. Colorado's public schools are severely underfunded: the state ranks 39th in the country in terms of per student funding for its schools, despite being the 14th wealthiest. Institutions like the Denver Museum of Nature & Science saw an opportunity to bolster educational offerings in their city. Within this context, the museum noted that one of the fastest growing groups in the city — the Latino community — was visiting the museum at disproportionately low rates, raising concerns about widening access and opportunity gaps.

By setting its sights on increasing visitation among this one demographic, the museum ended up reimagining how such institutions operate at a deeply structural level. "One of the most transformative things that came out of identifying that strategic audience focus was the way that we view ourselves and the way that we work with and for our community," explains Liz Davis, director of programs.

Curious, Creative, Playful The Denver Museum of Nature & Science set its sights on making sure that every student has the access, opportunity, and interest to take advantage of science education opportunities in the city. They've turned the tables on how science museums operate — not telling their audience what they need to know, but listening to what their audience is interested in. Their mission: "Be a catalyst! Ignite our community's passions for nature and science." © DENVER MUSEUM OF NATURE & SCIENCE

"Prior to this, we were doing what other museums traditionally do: we saw ourselves as the experts, and we would come up with what you need to know — whoever you are. It was always sound and accurate science, but we were paying very little consideration to what our audience might desire or what our audience might be interested in."

"What this work has allowed us to do is reframe how we operate," Davis continues. "Right now our model starts with, and is powered by, our community." After an initial year-and-a-half-long community collaboration project, in which volunteers from the city — including those who do not regularly visit the museum — volunteered their time to offer feedback on questions of what kinds of programs they might be interested in and what the museum's priorities should be in future, the museum developed a set of fundamental principles about how best to interact with their community. For the museum sector as a whole, notes Davis, this has been a revolutionary change. It prompted the institution to restate its strategic focus to make clear that it strives to design its programs to serve the needs and interests of its audience: "We're looking to attract more and diverse people to connect with nature and science in ways that are meaningful to them."

This approach has had a significant effect on initiatives like Denver's Urban Advantage program, which is supported by Carnegie Corporation of New York. The program there is being continually refined in response to feedback from Denver Public Schools administrators, teachers, parents, and students. This responsive model has also driven the museum's work in developing offsite programs in collaboration with local science teachers. "It's been a very iterative process. Usually for museums, our definition of finished product is 'it's perfect and it's done,' whereas this is very different, and it feels so much stronger because of that," says Davis. "For example, separate from the UA program, teachers asked us to develop team-based or collaborative projects that they could use in the classroom to teach science, so we created them. And the feedback from the teachers has been very positive — it helps with a sense of co-ownership of the project, and it helps us. We are always learning now. What we heard in refining the offsite programs helps us think about how we do things onsite."

Meeting People Where They Are

Chicago is notable for its racial diversity: almost 30 percent of its residents are Hispanic and almost 30 percent are African American. Its public school system, which serves 381,000 students, has faced underfunding, falling enrollments, and school closures in recent years — closures that left a number of primarily black areas without a single neighborhood school, to the chagrin of residents.

In this context, the Museum of Science and Industry, Chicago (MSI) has a strategy of moving its programs outside the institution's capacious walls — a quite radical approach to access. (The museum stands as the largest science museum in the western hemisphere, with more than 400,000 square feet of hands-on experiences.) As

Take a Number! The Museum of Science and Industry in Chicago cultivates science curiosity through offsite programs, including its Science Minors clubs, and onsite exhibitions like *Numbers in Nature*, which includes an 1800-square-foot mirror maze that provides endless fun while teaching kids about mathematical patterns in nature. PHOTO: J. B. SPECTOR/MUSEUM OF SCIENCE AND INDUSTRY, CHICAGO

Andrea Ingram, vice president of education and guest services, explains, getting young people to engage with what the institution has to offer doesn't mean simply eliminating barriers to accessing the museum — it means being strategic about how to get them through the door. And that process starts where they live. "Our Welcome to Science Initiative is laser focused on providing access and opportunity for youth where they are — that means in their families, in their schools, and in their communities."

The initiative incorporates museum-designed Science Minors Clubs — supported by a range of philanthropic, government, and corporate funders — that take place at out-of-school and afterschool sites where students are already spending their time. At the moment, 180 libraries, community organizations, and schools in underserved neighborhoods around the city receive curricula, materials, and instructional training through this program. Career fairs expose students and their families to the possibilities of STEM education by allowing them to meet professionals and discuss their interests and aspirations. And in a city where almost a third of the residents are African American, the museum's Black Creativity initiative offers culturally relevant science education programming to the community, showcasing the contributions of African Americans to STEM-related fields and offering targeted information on career and educational opportunities for black families. The program reaches tens of thousands of students, along with their teachers and families, in Chicago's underserved communities.

In all of this, explains Ingram, the goal is to increase capacity in the neighborhoods themselves: "With our community initiatives, we're really trying to build a synergistic relationship with the community organizations, with the families they serve, and with the children. We want families to see that the museum is a partner in their kids' education. Our approach is to give the people who are teaching our kids the tools they need to do so, whether that means parents, teachers, librarians, or even summer camp counselors who run programs in Chicago's parks."

Listening at the Local Level

For Carnegie Corporation's Kapur, much of this type of work with museums and centers fills a crucial gap in how foundations approach education. The ideal of meeting parents where they are has spurred investments in organizations working locally and directly with parents and communities, with an eye to increasing impact and effectiveness. "We hope that the local nature of the initiatives we're supporting will have a national impact — as well as resonance in other local communities."

"The lessons of the past years have told us that we all have to listen more," she explains. "We're always asking parents to buy into a concept — whether it's technology in the classroom, or personalized learning, or charter schools. But we can't always be telling — the listening piece needs to be there, too. That's what our attention to parent engagement is trying to achieve." ■

Learning in Space

Immerse Yourself! Design I/O combines high tech tools and an artistic sensibility in its exhibition design, which aims to encourage children's imaginative exploration in wondrous spaces. The design of *Connected Worlds* balances scientific accuracy and playfulness, focusing on getting kids to grasp complex concepts in a hands-on environment. PHOTO: DAVID HANDSCHUH AND DESIGN I/O

New approaches to getting kids engaged in STEM learning are driving new forms of architecture and design in science centers across the country. As more museums deepen their embrace of hands-on, experiential, inquiry-driven models of engagement, they are tailoring their spaces to make such activities possible.

Theo Watson and Emily Gobeille are partners in Design I/O, a creative studio specializing in immersive installations. Watson says that the company began working with science museums only a few years ago. It was a moment when institutions like the New York Hall of Science (NYSCI) had begun searching for ways to make their exhibits more engaging — less focused on information delivery and more on sparking curiosity and allowing for child-driven inquiry. "Up until that point, we hadn't seen our work as belonging in a museum context; we saw it as working in an intersection of art, design, and technology, without the pedagogical content needed for a typical science museum," he says. "But that was also the time when I think science museums were trying to be a little less typical as well — they were moving away from the pedagogical a little bit."

Design I/O's first foray into the world of science museums was a collaboration with NYSCI that resulted in the museum's wildly popular exhibition, *Connected Worlds*. Combining design, illustration, projected image, and technology, museum visitors can shape one of several biomes — jungle, desert, wetland, mountain valley, reservoir, plains — by rerouting a common water supply and seeing how it affects plant and animal life. They soon discover that whatever happens in one part of the exhibit triggers changes in the others — so damming a stream in the wetlands might lead to transformations in the desert. By focusing on fun, imagination, and a sense of playfulness, *Connected Worlds* teaches kids and adults alike about such high-level concepts as feedback loops, dynamic environments, equilibrium, and causal links between what we might think of as discrete geographic places.

Watson and Gobeille had developed some of these ideas in a smaller project, *Funky Forest*, done for a children's festival in the Netherlands a few years earlier, but bringing this work into a science museum created new opportunities and challenges. For one, there was the novel experience of collaborating with top scientists and researchers from MIT Media Lab, NYU's Games for Learning Institute, Columbia University's Earth Institute, and so on, who were part of NYSCI's development team.

"There was some early discussion about how realistic or scientific the system we were building should be, and there were talks about whether we should be incorporating the real way that, say, aquifers and water systems function, and about whether we could even realistically model that in a real-time installation," says Watson.

"There was a push and pull between the science and the art," he explains. "What we realized was that we had to prioritize the learning goals — encouraging systems thinking and sustainability. We realized the world doesn't have to be a realistic world — if what we want kids to understand is feedback loops, then the creatures don't have to be real creatures, the plants don't have to be real plants, and so on. And in fact what we found is that the more unfamiliar the creatures were the more likely kids were to approach the experience with fresh or neutral eyes. It was a great encouragement for us to keep things weird."

"When we were thinking about what the exhibition would look like, we had a sense of what we wanted and what we didn't," says Margaret Honey, the museum's president and CEO. "We wanted it to make you feel powerful. We wanted it to make you feel like you had superpowers. We realized as soon as we saw their previous work that Emily and Theo were creating exactly that. Design I/O pushed us to up our game. They understand the importance of play and discovery and exploration, and they are computational and artistic geniuses on top of that. They raised the bar on what is possible in a science museum."