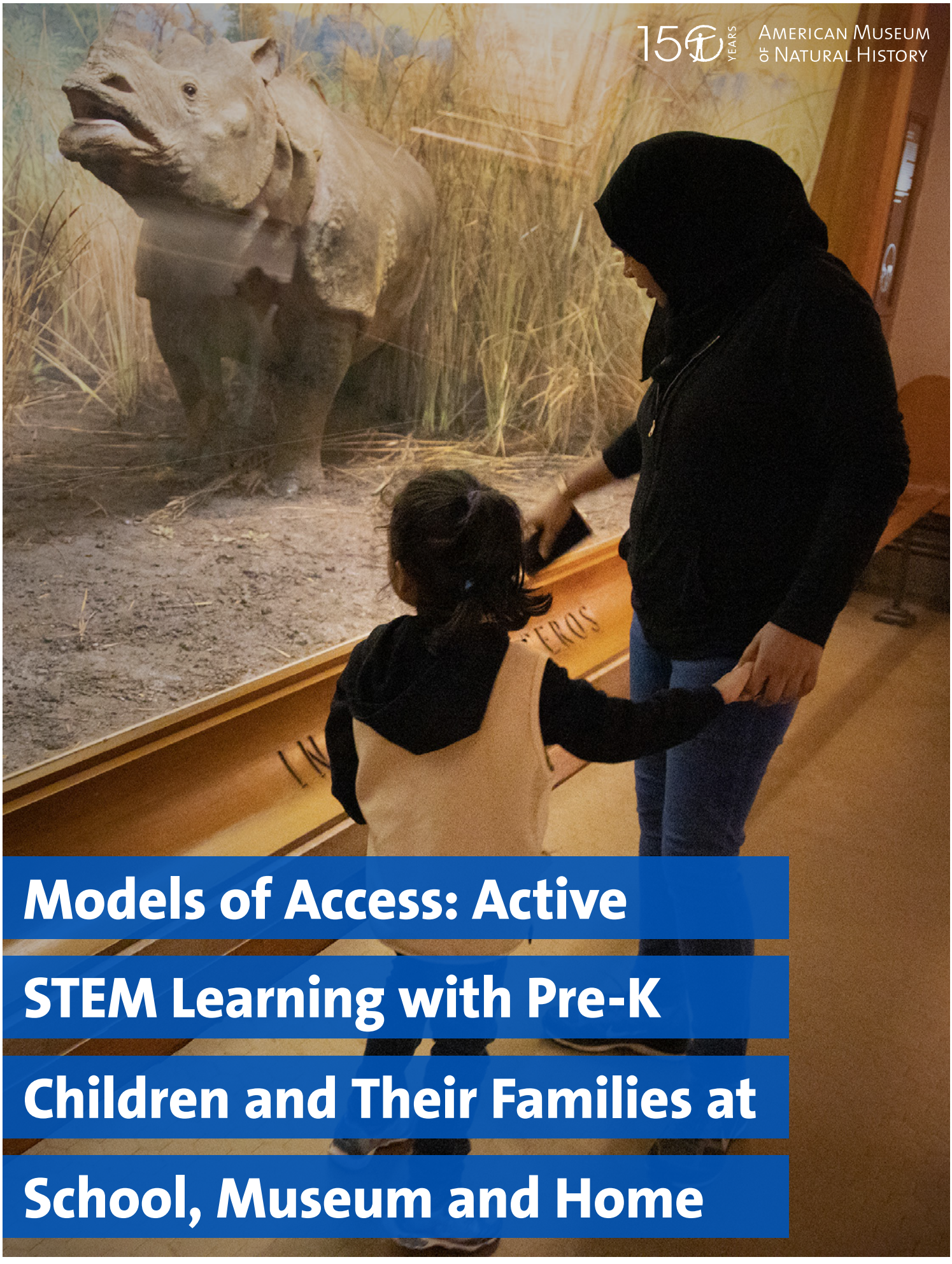

Models of Access: Active STEM Learning with Pre-K Children and Their Families at School, Museum and Home

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JUNE 2019

Executive Summary

The Initiative
Active STEM Learning with Pre-K Children and Their Families at School, Museum and Home: Models of Access

In 2017–2018, the American Museum of Natural History ("the Museum"), with support from 100Kin10, embarked on an initiative to implement and evaluate models of early-childhood science learning across different learning settings for young children and their families, in order to deepen its reach to support quality early science learning for increased numbers of children and families from its New York City, Upper West Side community. This Models of Access Initiative ("the Initiative") launched in June of 2017 and was implemented during the academic year until June 2018.

With more than 20 years of practice, the Children and Family Learning (CFL) group at the Museum led the Initiative with partners including Goddard Riverside Head Start (GRHS), the Bloomingdale Family Program, and the New York City Department of Education Pre-K programs at P.S. 84 and P.S. 111. A longstanding partnership between GRHS and the Museum built a foundation of knowledge about partnerships and active science learning with families. The model of access for the GRHS families involved providing learning experiences directly to the families as they attend classes at the Museum with their teachers weekly throughout the school year. A component of that model also involved providing professional learning for the teachers on a monthly basis, with the intention of integrating Museum learning deeply into children's school learning. With Bloomingdale and the public Pre-K classrooms, a new model focused on a year-long set of activities centered around teacher learning at the Museum and in teachers' classrooms; the model included family engagements in both settings, along with extended, structured visits by children and their teachers to the Museum throughout the year.

This Models of Access report summarizes the work of the Initiative and provides findings from the 18-month pilot program: *Models of Access: Active STEM Learning with Pre-K Students and their Families at School, Museum, and Home.*

Findings and Recommendations

The evaluation and research for the Initiative was focused on the following lines of inquiry:

1. In what ways might institutional partnerships provide opportunities for greater numbers of early learners to gain access to quality early-childhood science learning?
2. What can we identify as meaningful learning experiences, learning environments, and content resources to support early-childhood teachers in their efforts to become confident educators of science and to gain the skills and knowledge that can give young learners strong science foundations?
3. What does science learning look like for young children and families?

By sharing a common focus on early-childhood science learning, partnerships between an informal science institution and institutions with Pre-K classes amplified science as a priority for participating organizations. Because sharing a common focus creates a sense of community and elevates opportunities to talk about that focus, the focus becomes a priority for partners. We recommend having administrators from partner institutions participate together in conversations about early-childhood science at least once a year and with the leadership from the informal science institution at least monthly throughout the partnership to maintain the focus on early-childhood science and keep it a priority for their schools.

Selecting partners with supportive leadership from each of the institutions empowered teachers to transfer their professional learning experiences to the classroom. To be effective, professional learning takes time and needs to be directly applicable to and practiced in teachers' classrooms. Administrators therefore play a large role in ensuring that professional learning transfers to classroom practice. We recommend selecting partner institutions that have school leaders who "buy in" and support the work at their school sites.

Family events and parent/child classes at the Museum served as opportunities for parents at partner institutions to be directly exposed to early-childhood science and encouraged their participation in their children's science learning. Because parents are greatly influential in their children's learning, it is important to involve them directly in science learning with their children. We recommend creating science learning opportunities explicitly for parents and children together.

Each model in the Initiative has potential for positively influencing young children's access to high-quality early science learning. By undertaking three additional partners alongside the GRHS partnership, the Museum greatly expanded its support of early science learning for children from low-income communities. Over the course of the year, more than 45 early-childhood teachers supporting more than 300 two-, three- and four-year-old children participated in the program. The teachers attended eight or nine professional-learning sessions at the Museum, totaling 20–25 hours for each teacher. Each class visited the Museum twice with their teachers. Each community—children, families, teachers, and administrators—attended one "family fun night" after hours at the Museum. Aside from GRHS, teachers from each of the other sites attended 4–5 professional-learning sessions with Museum educators; Museum educators also attended parent orientation sessions at each of the sites.

Because there are trade-offs in designing programs for large numbers of children and families versus smaller numbers, we recommend finding ways to do both. The model that emphasized professional learning for teachers had the potential to expose more children to high-quality early science learning in more settings. The model that emphasized weekly family classes, on the other hand, reached fewer children, but was able to provide deeper and more-foundational learning experiences.

Through the partnership work, Pre-K educators were engaged in hands-on and experiential learning activities. They took up the role of student and learner, creating a dynamic that differed greatly from that of traditional professional development. Because early-childhood educators often come to their position having had few positive experiences in their own learning of science, it is important to provide them with learning experiences that situate them as learners of science. We recommend engaging teachers in several learning experiences over time, using the SIMPL model and integrating play, that are relevant to the curriculum content they teach and are appropriate for teaching early learners.

Learning experiences involved participating in a community focused on co-generating an understanding of early-childhood science learning. Because teachers are more likely to apply their professional learning to their classroom when it is grounded in their day-to-day teaching practice, it is useful to situate teachers in a learning community where they are able to discuss their own teaching and learning experiences and generate understandings together. We recommend professional-learning experiences that allow teachers to contribute examples of science teaching and learning from their own early-childhood classrooms that can be used to come to common ideas about best practices in early-childhood science.

Teachers became acquainted with new resources and activities through exposure to the Museum classrooms and opportunities to leverage Museum assets in their own teaching. Because informal science institutions provide learning environments unlike classrooms, early-childhood teachers can be inspired and engaged in science learning in novel and authentic ways. We recommend using the informal institution as a catalyst by exposing early-childhood teachers to a variety of learning environments and explicitly supporting them in considering how these learning experiences could inform their decisions in selecting or designing learning environments for young children.

In the Initiative, early-childhood educators gained knowledge and skills for building strong science foundations. Because teachers learn from observing the practice of others, we recommend providing them with opportunities to observe Museum educators facilitating early-childhood science lessons in Museum classrooms and Halls. Observing Museum educators can help early-childhood educators consider their own teaching and learn new ways to invite early learners into conversation, engage parents in children's learning, and select interesting objects and organisms that can serve as teaching tools in their own classrooms.

Teachers in the Initiative were inspired by the design of the Museum spaces and resources. Each time teachers visited these classroom spaces, they made note of materials that they thought their students would enjoy. In other cases, their exposure to the live animal collections inspired them to adopt a pet in their own classrooms.

Children were able to explore, learn, and play in science-rich environments that seeded new conversations and ideas that traveled back to their classrooms and, at times, to their homes. Because young children learn science through their own experiences, exposing them to science phenomena, practices, language, and concepts is essential for building a foundation for lifelong curiosity about science and nature, and for later school learning. We recommend working not only with teachers, but also with parents, to support them in helping young children see science in the world around them and enrich the opportunities for science learning that happen every day in school, at home, and anywhere a child may visit.

THE RESULTS OF THE INITIATIVE SUGGEST TWO FRUITFUL PATHWAYS FOR EXPANDING ACCESS TO EXEMPLARY EARLY-SCIENCE LEARNING. They also indicate where further study and design experiments may deepen our understanding of how people learn in school and throughout life. For example, through careful selection of community partners, the Museum had the opportunity to further understand how its learning approaches might be shared with communities from diverse socioeconomic, cultural, and linguistic backgrounds. However, further research is required to understand the ways in which specific strategies, such as having bilingual Museum educators, support teachers' or children's learning. Similarly, the Museum would like to perform additional research on how parents' participation in Museum programs may contribute to families' perspectives of science and capacity for learning science. Finally, questions remain about how high-quality science-learning experiences complement or support early learning more generally. Future work should account for these opportunities to learn more about young children's learning of science in museums, at school, and at home.

Introduction: Access to Early-Childhood Science

The Motivation: The Importance of High-Quality Science Learning for Children

Recent studies have noted the benefits of high-quality learning experiences for young children (Wechsler, et al, 2016). Nationally, states have been investigating strategies for promoting and funding high-quality and equitable learning opportunities for children from birth through age five, as positive outcomes have been noted for individual children, families, and society as a whole (Wechsler, et al, 2016). Children, even babies, have a greater capacity for understanding the world around them than previously thought; therefore, science education for young children is a worthwhile endeavor (National Research Council, 2007; Metz 1995).

Science, and more broadly its related fields of technology, engineering and math—now popularly framed as STEM, have gained extensive attention in the United States from the time of Sputnik to today, as concerns about American economy, competing internationally, the environment, healthcare, and diversity in the STEM fields have come to the fore in politics, media, and among the general public (National Research Council, 2005; National Governors Association, the Council of Chief State School Officers, & Achieve, Inc., 2008). The Museum has been on the front lines throughout this history working as a science research institution, and as a provider of science education, collaborating on national policy (Carnegie/IAS, 2009).

Updated national standards in science education—the Next Generation Science Standards —have established a new vision for success in learning science (NGSS Lead States, 2013). This vision involves engaging learners in doing science in order to construct an understanding of science phenomena and identify connections among the core science disciplines: Earth and Space Science; Life Science; and Physical Science (National Research Council, 2012). Several states have adopted or adapted the NGSS and have implemented them in K-12 schools. New York State also added Pre-K standards that integrate the three dimensions of the K-12 NGSS (NYS Education Department, 2016). The vision

of science learning promoted by the NGSS and described in A Framework for Science Education (National Research Council, 2012) can begin long before children reach school age. An early science education can contribute to the experiences and sophisticated foundational understandings children bring with them when they enter school and can help them to develop skills to think conceptually, maintain curiosity, and problem solve throughout their lives (Hadani & Rood, 2018; Metz, 1995; National Research Council, 2007; Rood & Hadani, 2016). Young children can learn science in many environments supported by their families or by educators (McClure et al, 2017; Rood & Hadani, 2016).
Families play a critical role in inspiring and supporting students' academic engagement and learning (Henderson & Mapp, 2002; Juang & Silbereisen, 2002). There is no greater influence on a student than his or her family. Improving science learning will require reaching out to families and gaining their support. Families can play numerous constructive roles. First and foremost, they need to understand how science learning fits into their children's progression through school and its importance as a foundation for future success. Parents can also actively support their children's learning outside of school by taking them to informal science institutions (Crowley et al., 2001; Goodwin, 2007), promoting their reading of science-related books and magazines (Crowley & Jacobs, 2002; Jacobs & Bleeker, 2004), and participating in science discourse (Blum-Kulka, 1997; Callanan, Shrager, & Moore, 1995) and science-like activities (Tenenbaum & Leaper, 1997).

Teachers are also positioned to contribute to the science learning of young children. As cities such as New York offer free early learning programs through Universal Pre-K initiatives, more children and younger children will be exposed to formal learning, which ideally will include high-quality science.

The Challenge: The Current State of Science Education for Early Learners

While it is clear that children can learn science early and that it greatly benefits them throughout their lives, the amount and quality of early science-learning opportunities available to them remain variable, especially between the ages of 0-5. The challenges and barriers that result in this variability have been identified within the current system and can be addressed by informal science learning institutions, such as the Museum (Haverly, n.d.).

Young children are developing ideas about natural phenomena from birth, and deepening their science education can nurture their scientific tendencies. However, teachers' perceptions of science and their understanding of how children learn science often result in didactic approaches to science teaching and learning (Trundle & Sackes, 2015). Teachers perceive young children as having a high capacity for learning, which heavily influences their teaching. However, researchers have yet to examine teachers' perceptions of children's ability to learn science in particular. This may be one reason science is taught less frequently. (Saçkes, 2014).

In the Models of Access Initiative ("the Initiative") the Museum and its partners set out to explore best practices for developing Pre-K teachers' science teaching capacity, which involves ensuring educators have the tools, knowledge and orientation to integrate science into their practice. The premise here is that any effort to improve student learning will have to begin by strengthening the education workforce (Desimone, 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001; Jeanpierre, Oberhauser, & Freeman, 2005; Wei, Darling-Hammond, Andree, Richardson & Orphanos, 2009). Pre-K educators are more likely to implement science in their classrooms when they have had their own positive academic or informal science-learning experiences (Saçkes, 2013). Analyses of Pre-K teaching and learning have revealed that educators are more likely to focus on developing children's literacy and numeracy than their science skills (Clements & Sarama, 2016). Pre-K educators themselves do not often have exposure to substantive science education, and the professional-learning opportunities related to science are limited (Marshall, n.d.; Saçkes, 2013).

One barrier is the lack of opportunities for Pre-K educators to be immersed in science experiences. Teacher certification policies require little science expertise and few science courses that may be replicated in teachers' classrooms to help teachers explore what authentic science learning looks like and develop a positive science identity (National Research Council, 2012; Smith & Neale, 1991). Compared to educators in middle and high school, early and elementary educators are less likely to have expertise in science content (Isenberg, 2000). If they are given strong professional development, along with the time and space necessary to expand their practice and content knowledge and to bring science into the classrooms, teachers can effectively provide quality learning experiences that foster science skills in young children (Roth, Goulart & Plakitsi, 2012).

Beyond lack of access to high-quality professional development, there are other barriers—systemic or at the program or school level—that educators and school leaders confront in supporting their schools' STEM capacity in Pre-K. Pre-K teachers, especially in Community Based Organizations (CBOs), are facing challenges that come with New York City's shift in the early-childhood field. In 2017, New York City Mayor Bill de Blasio announced a "3-K for All" initiative, an extension of Universal Pre-K, which will create thousands of seats for young learners in Pre-K centers (Taylor, 2017). The result, however, is a divide between Community Based Organizations (CBO) and Department of Education (DOE) schools. The DOE offers higher pay and more time off, and has access to more substitute teachers than CBOs (Barnett, 2003). In contrast, Pre-K teachers in Community Based Organizations struggle to find time to refresh curriculum, develop science content, or collaborate with fellow educators. Additionally, retention in the CBO environment is low (Taylor, 2017). Newer educators require adjustment periods in which they rely on content areas they are most comfortable in: literacy and mathematics. With continual staff turnover, a focus on science takes a back seat.

Informal institutions, such as the Museum, other museums, botanical gardens, zoos, etc. (NRC, 2009), can help create and nurture authentic opportunities for Pre-K teachers, parents, and caregivers to support children's STEM learning and build parents' and caregivers' own capacity to support their children's science learning and inclinations. Informal science institutions provide fertile ground for integrated and complementary engagement strategies for young learners and their families (Ellenbogen, Luke, and Dierking, 2007). Teacher professional learning in the out-of-school settings can inform their use of the cognitive tools and resources available to engage young learners in "authentic science activities" (Brown, Collins, & Duguid, 1989; Luehmann & Markowitz, 2007; Melber & Cox-Peterson, 2005). Because institutions like the Museum house scientists who are engaged in real scientific research and the displays in the Halls offer several examples of scientific phenomena, they are well positioned to encourage families' enhanced science interest and understanding (Eshach, 2007; Tisdal, 2004; NRC, 2009). Science-rich institutions can also support the integration of real science learning into the curriculum by providing curricular material and professional development (Phillips, Finkelstein, & Wever-Frerichs, 2007; Carnegie/IAS, 2009). As the National Research Council (2009) states:

> Partnerships between science-rich institutions and local communities show great promise for structuring inclusive science learning across settings, especially when partnerships are rooted in ongoing input from community partners that inform the entire process, beginning with setting goals.

Indeed, there are indications of the positive impact of the Museum programs on children and family science learning from studies of families and alumni of the Museum Science and Nature Program (a full description and history of the program appears in the Partner Focus section of this report). Parents share that they feel better equipped to facilitate their children's science learning in places outside the Museum (such as, for example, the park or the beach) after hearing how educators in the program ask questions and support inquiry. Alumni of the Science and Nature Program have said that even if they haven't selected a science field of study, they still felt better prepared for school science classes and more able to tackle challenging questions and problems than they would have if they were not part of the program. They also report a greater connection to nature than their peers, regularly seeking out activities in natural or wilderness settings (Giusti & Chittenden, 2012).

Testing New Models and Expanding Access

Based on years of experience, the Museum has determined that **developing partnerships with schools and community-based organizations is a successful strategy for expanding access to high quality science for young children and their families.** In 2017-2018, the Museum, with support from 100Kin10, embarked upon an initiative to implement and evaluate models of early-childhood science learning across different learning settings, including the Museum and Pre-K classes, for young children and their families, in order to deepen its reach to support quality early science learning for increased numbers of children and families from its community on the Upper West Side of New York City. The Initiative launched in June of 2017 and was implemented throughout the 2018-2019 academic year.

With partners including Goddard Riverside Head Start (GRHS), the Bloomingdale Family Program, and the New York City Department of Education Pre-K programs at P.S. 84 and P.S. 111, the Museum considered the following questions. These questions guided a deep exploration into the ways in which the Initiative could give insight into science learning for young children at school, at the Museum, and at home:

- In what ways might institutional partnerships provide opportunities for greater numbers of early learners to gain access to quality early-childhood science learning?
- What can we identify as meaningful learning experiences, learning environments, and content resources to support early-childhood teachers in their efforts to become confident educators of science and to gain skills and knowledge that can give young learners strong science foundations?
- What does science learning look like for young children and families?

The longstanding partnership between GRHS and the Museum built a foundation of knowledge about partnerships and active science learning with families and teachers. The model of access for the GRHS families involves providing learning experiences directly to the families as they attend classes at the Museum weekly with their teachers throughout the school year. A component of that model also involved professional learning for the teachers on a monthly basis with the intention of integrating the Museum learning deeply into children's school learning. This professional-learning component allowed teachers in GRHS to examine their practice and better support their young learners in making connections to support new science learning. As a result, the question arose of whether offering professional-learning opportunities to teachers of Pre-K children might provide broader access to active STEM learning.

In this Initiative, the Museum piloted a new model of partnership intended to expand the number of children and families that the Museum might serve. With Bloomingdale and the public Pre-K classrooms, this model focused on a year-long set of activities. These centered around teacher learning at the Museum and in the teachers' classrooms; they included family engagements in both settings and extended, structured visits by children and their teachers to the Museum throughout the year.

Evaluation and research were conducted during the implementation of the new model. The aim was to recommend an extension of the Museum support for early-childhood science learning with a goal of identifying the most useful and engaging programs and practices for the children, families, and agencies and schools involved.

The following sections of this report **Active STEM Learning with Pre-K Learners and their Familes at School, Museum and Home: An Initiative to Develop Models of Access** will provide readers with a broad understanding of the Initiative and the resulting findings and recommendations from the year of implementation and deep inquiry into the work.

Section III. Partners in Focus: Institutional Partners Invested in Early-Childhood Science includes information about each of the partners in the Initiative and highlights early-childhood and science-teaching philosophy and curricular approaches, as well as ways in which the institution involves families in children's learning along with the role of the institution in this Initiative.

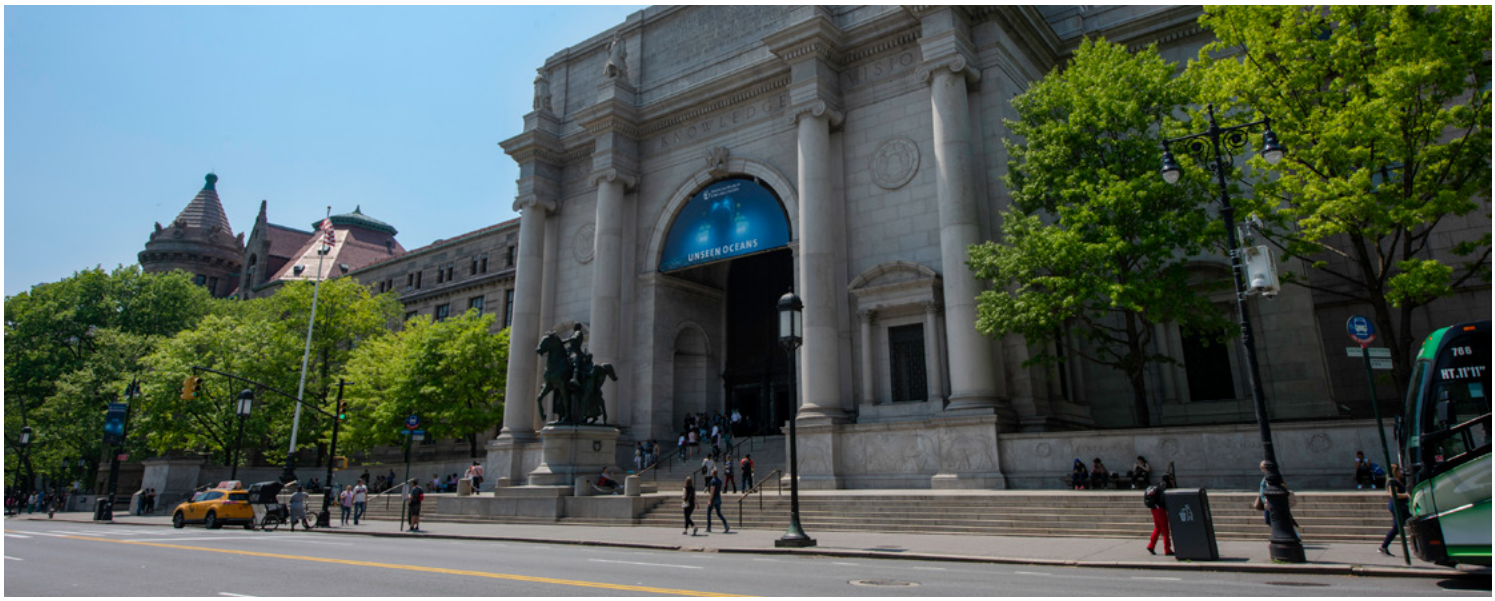
Section IV. Partnership Roadmap: Implementing the Initiative describes the research-based and iterative design approach used to structure the implementation of the Initiative; it also adds specific examples of the partners' experiences and approaches to examining those experiences throughout the year.

Section V. Insights: What we Learned about Supporting Early Science Learning provides high-level findings from the research on the Initiative and rich examples from the work that support the findings.

Section VI. References, VIII. Appendices, and IX. Acknowledgements are also shared for those who are interested in:

1. more details about the experiences designed as part of the Initiative;
2. additional reading in the literature based on early-childhood science learning, teachers' professional learning and partnerships; or
3. the individuals involved the Initiative.

Partners in Focus



Institutional Partners Invested in Early-Childhood Science

The Models of Access Initiative is a partnership among the Museum and the participating organizations that serve Pre-K learners, with financial and capacity-building support from 100Kin10 and the endorsement the New York City Department of Education. This inclusive and shared leadership approach influences several key substantive and operational objectives:

- Creating shared vision for the goals of the initiative;
- Creating an understanding of the different assets that each partner brings to the table;
- Creating strong lines of communication to address hurdles or barriers during implementation;
- Establishing trust among different individuals and communities to build a foundation from which to sustain a long-term partnership.

The following profiles describe each organizational partner and its role in the Models of Access Initiative.

American Museum of Natural History

Founded in 1869, the American Museum of Natural History is today one of the world's most renowned natural history museums.Every year, millions of visitors explore science and the natural world in the Museum's iconic permanent halls and special exhibitions. The Museum is at the forefront of research, with over 200 scientists investigating novel questions in the disciplines of anthropology, astrophysics, biology, Earth and planetary sciences, and paleontology.

Through its Education Department, the Museum's broad education leverages its permanent halls, rotating special exhibitions, and extensive scientific assets to respond to issues of local, national, and global concern. Science—including scientific thinking, exploration and inquiry, and science content—underlies many of our world's most pressing challenges, and the Museum broad education agenda responds to the critical need to equip visitors of all ages and backgrounds with the knowledge and skills to engage with these challenges thoughtfully and become lifelong learners. Equally important, the Museum strives to prepare a new generation for career opportunities in science, technology, engineering, and math (STEM) fields—whether as scientists or in the growing number of professions that require STEM competencies.

AMNH Education has forged a continuum of formal and informal learning opportunities ranging from early science programs for preschool children, family science programs and youth research mentorships, to Ph.D. in Comparative Biology and Master of Arts in Teaching Earth Science programs in its Richard Gilder Graduate School and lifelong learning opportunities for adults.

Early-Childhood Education at the Museum

The Children and Family Learning (CFL) group at the Museum is dedicated to providing young children and their families with exemplary science learning. Unique to CFL is a longstanding focus on early-childhood learning and family learning that acknowledges the critical roles of each to set a foundation for science learning early in a child's life (Hadani & Rood, 2018; McClure et al, 2017; Early-Childhood STEM Working Group, 2017). Each program is designed to engage children and their parents in the wonders of the natural world and to motivate inquiry through direct exposure to scientists, the work of scientists, and scientific and natural phenomena that can be explored within the Museum. CFL's pedagogical approach emphasizes providing children with learning experiences that are exploratory, playful, and aligned with the science disciplines of the Museum. Learning is guided by instructors who are knowledgeable about young children and about science and who support children in making connections to other familiar experiences, objects, and living things as they learn. CFL educators explicitly support parents in the learning process alongside their children—noting the critical role parents play in their children's learning and in their attitudes toward science.

The *Science and Nature Program*, established in 1998, was originally designed for young learners, ages 4 and 5, who, together with their parents, participate in immersive weekly learning throughout the year. It has since grown to provide a curriculum for children ages 3 to 11. The *Discovery Room*, a distinct gallery within the Museum originally built in the 1970s and upgraded to a collections-rich "gateway to the Museum" learning space in the 1990s, serves children ages 5 and up and their families on a daily drop-in basis. Additional programs have since been developed, building on the on the Museum's deep experience with young children and families, including school-year classes for preschool-age children and their parents and summer camps for upper elementary–school age children. Importantly, the Museum approach to children and family learning is inclusive of diverse communities. Since 1998, the New York City Upper West Side community-based organization Goddard Riverside Head Start (GRHS) has been part of the Science and Nature Program, and, most recently, the Children and Family Learning group is supporting a citywide children and family engagement program open to families in New York City Housing Authority communities. In FY18 the CFL served approximately 1,200 children and families across all programs and over 120,000 families in the Discovery Room.

The Museum pedagogical approach emphasizes providing children with learning experiences that are exploratory, playful, and aligned with the science disciplines of the Museum. In Museum programs, learning is guided by instructors who are knowledgeable about young children and about science and who support children in making connections to other familiar experiences, objects, and living things as they learn. Additionally, the Museum explicitly supports parents in the learning process alongside their children—noting the critical role parents play in their children's learning (Haden, 2010) and in their attitudes toward science (George & Kaplan, 1998).

The Museum's Role

The Museum was the lead partner for the Initiative. As lead partner, the Museum raised the funds for the project; participated in the national 100Kin10 network for capacity-building; and ensured that the project goals were met. The Museum's responsibilities included facilitating meetings, communications, and workshops for professional learning; facilitating family events; and conducting the evaluation of and research for the Initiative.

Throughout the Initiative, the Museum supported conversations about **STEM learning for young children** with both administrators and teachers from the partner sites. While the overarching conversations were about **STEM learning**, the Museum primarily focused upon practices in **science teaching and learning** in teacher professional learning and children and family learning experiences. This included learning experiences that spanned several of the disciplines represented in the Museum's halls and in the research of Museum scientists, including anthropology, paleontology, and biology among others.

AMNH Design Principles

Parent and Child Participation

Leveraging the Resources in the Museum

Exposure to Scientific Phenomena

Engaging in Science Practices

Focus on Developmentally Appropriate Pedagogy

Strengthening Access and Equity

Goddard Riverside Community Center

Goddard Riverside Community Center was established in 1959 when two historic settlement houses merged: Riverside Community House, founded in 1887, and Goddard Neighborhood Center, founded in 1892. Drawing upon the 19th-century vision of settlement houses providing community-based services for low-income families, Goddard Riverside is responsive to the ever-changing landscape of New York City, creating partnerships and focusing its services where they are most needed. Today, Goddard Riverside serves approximately 17,000 individuals each year through 26 programs at 21 locations throughout Manhattan. In addition to serving young children and youth, Goddard Riverside serves older adults through their Senior Center, offering exercise classes and social activities, affordable housing units and home-delivered meals. The Goddard Riverside Law Project provides community members with free or affordable legal services for housing cases. Goddard also offers counsel on benefits such as food stamps and health care and conducts homeless outreach.

Goddard Riverside offers comprehensive early-childhood education programs for children ages two to five. Its Day Care program—offered at its 91st Street, 83rd Street and 64th Street locations — serves approximately 201 children a year. Its Head Start program at the 95th Street location (GRHS) serves 32 children. The children at GRHS come from culturally and linguistically diverse backgrounds. In the 2017-2018 school year 28 percent of children were nonnative English speakers; 67 percent identify as Hispanic or Latino; 3 percent identify as Asian; 10 percent identify as black or African American; and 20 percent identify as being mixed races. Additionally, 94 percent of the children qualify as low-income and 25 percent have special needs. All children benefit from Goddard Riverside's partnerships with local museums, schools, and social service and health organizations. Parents and guardians volunteer in classrooms, serve on program committees, attend workshops, and participate in activities with their children. At the 64th Street location, the children are a part of a larger community center and interact with the senior citizens through organized activities such as costume parties and other intergenerational events.

Each center uses the **Creative Curriculum** as a foundation for classroom activities that promote intellectual, social, emotional, and physical growth through hands-on exploration of science, nature, and art. The shared curriculum fosters collaboration between the Day Care programs and the Head Start program. Goddard Riverside focuses on helping children learn through play, and the pedagogical approach is largely child-driven. The teachers pay close attention to what their young learners appear to be interested in and use children's interests to drive curricular decisions, catering to each child's abilities and pace of learning.

Children are given the opportunity to be independent and choose the play areas in which they want to spend time. Each play area is open all day, and through play they learn how to use their small muscles, interact with friends, and develop math and inquiry skills. They can choose the library area, the dramatic play area, the dress up area or the pretend kitchen. Teachers use an online tool called **Teaching Strategies Gold** to support their assessment of student learning. The tool recommends questions that the teachers can use with their young learners to understand how their students learn and what they are learning, and to reflect on what they have worked on in class.

There are varied hands-on science opportunities that are a part of the overall learning settings at Goddard Pre-K programs. Every early-childhood classroom has a science table that allows young learners to engage in hands-on activities, including basic science and engineering practices with blocks and composting projects, and each classroom has at least one animal, such as a hamster or fish. Each center has a lending library available so parents can borrow books to read to their children at home.

Teachers at Goddard Riverside post pictures around the classroom of children participating in active science-learning activities, such as observing caterpillars and butterflies. The pictures serve as a conversation starter between the teachers and parents when the parents visit the classroom to drop off and pick up their children.

GODDARD RIVERSIDE COMMUNITY CENTER ROLE

Goddard Riverside is the longest-standing community partner with the Museum for Pre-K children and family learning. The Museum and Goddard Riverside developed a specific model of Museum on-site weekly family classes for Head Start and Pre-K families that has been part of the larger Science and Nature Program since 1998.

Given the Museum's long relationship with Goddard Riverside, Goddard Riverside's leaders and staff played a strong role in co-constructing the partnership architecture, the program design, the design for professional learning, and family involvement.

GODDARD RIVERSIDE MISSION

Goddard Riverside's mission is "to work every day for a fair and just society where all people have the opportunity to make choices that lead to better lives for themselves and their families." Goddard Riverside Early Childhood focuses on helping families thrive by providing safe, enriching environments for young children that promote intellectual, social, emotional, and physical growth.

Bloomingdale Family Program

The **Bloomingdale Family Program** was founded in 1960 when a group of families from diverse ethnic, cultural, and socioeconomic backgrounds came together to create a free, integrated preschool for the children in their community. For the first five years, Bloomingdale's parent volunteers—assisted by workers from New York City's Parks Department and Health Department—operated a free preschool for 70 children in space provided by the Children's Aid Society. Monthly fundraising events—bake sales, craft fairs, potlucks, and rummage sales—provided funds for materials and school supplies. Mothers and fathers from different ethnic and economic backgrounds became involved in their children's learning as they worked together to support and maintain the program. Bloomingdale has operated a full-time Head Start program since 1969.

The mission of Bloomingdale Family Program is to serve preschool children from low-income families in upper Manhattan. The educational program aims to foster children's growth in all areas of development—intellectual, physical and emotional—and builds a foundation for success as they begin their educational journey. Bloomingdale welcomes children with special needs and provides the individual support services they need to become competent and successful learners. Bloomingdale has 135 children in three early-childhood centers, with 10 bilingual classrooms. Ninety percent of Bloomingdale students are Title I eligible.

Supported by a mix of federal, state, and local funding and philanthropic contributions, Bloomingdale is able to provide a supportive suite of services for children and families. For example, Bloomingdale offers one-to-one play therapy in which special-education teachers and therapists meet with individual children, bilingual speech therapy and occupational therapy, and health and nutrition services to ensure all children receive regular medical exams and dental care. The centers also provide each child with meals and snacks and ensure daily outdoor activity.

At Bloomingdale, the staff focuses on engaging and working with parents as partners in the educational process, providing the space and opportunity for parents to be advocates for their children and build their self-development and community involvement. Bloomingdale organizes regular meetings to support parents, including a mothers' group and a fathers' group, and provides specific workshops on topics such as applying to kindergarten, finding employment and children's health resources. The Parent Leadership Project (PLP) hosts discussions with parents about quality education. Teachers host class meetings with parents once a month to share what is happening in their classrooms. In addition to working closely with families, Bloomingdale provides children with continuing support as they transition into elementary school. Their Homework Help program gives afterschool homework help for children from kindergarten through third grade.

Bloomingdale provides a learning environment that encourages children to explore, experiment, communicate, and express their feelings, and become eager and confident learners. Bloomingdale adopted the **HighScope curriculum** in 1987 to create a child-centered learning environment that gives teachers the resources and assessment tools to guide their practice. HighScope complements and supports Bloomingdale's guiding philosophy, which puts the individual child at the heart of the program. Teachers work with parents to set goals for each child, and activities are designed to support the child's continual growth and progress.

Preschool teachers at Bloomingdale Family Program start the school year with home visits to meet and speak with the parents about their goals for their child's learning through the upcoming year and observe how children play and what they have access to at home. Bloomingdale teachers also facilitate meetings for the mothers' and fathers' groups and offer suggestions on activities to do with children at low cost, such as free museum visits with New York's Cool Culture Pass.

The children in Bloomindale Family Program come from culturally and linguistically diverse backgrounds. In the 2017-2018 school year 30 percent of children were nonnative English speakers; 17 percent identify as black or African American. Of the children 58 percent live below the poverty line.

BLOOMINGDALE FAMILY PROGRAM ROLE

The Museum and Bloomingdale established a relationship during a prior Initiative and have continued to find ways to partner since that project; the Bloomingdale community is located within 2 miles of the Museum. Prior to the Initiative, the Museum provided Bloomingdale with guided visits for their Pre-K classes and community, and in recent years the Museum began to work more closely with Bloomingdale educators to support science learning in their classroom.
For the Initiative, Bloomingdale served as co-constructors of the partnership architecture and co-developers of their professional-learning program. Bloomingdale also supported their educators to engage in the project and were the lead liaisons for the families of their community.

HOW BLOOMINGDALE FULFILLS THEIR MISSION

The Bloomingdale Family Program fosters children's growth in all areas of development—intellectual, physical, and emotional—and builds a foundation for success as they begin their educational journey.

New York City Department of Education

The New York City Department of Education (NYCDOE) is the largest public-school system in the United States, with more than 1.1 million students. Seventy-four percent of students are economically disadvantaged; almost 20 percent are students with disabilities and 13.5 percent are English Language Learners. Demographics identities include 40.5 percent Hispanic, 26 percent black or African-American, 16.1 percent Asian, and 15 percent white.

In 2014, New York City launched a major expansion of its public Pre-K program, more than tripling the number of children in Pre-K within three years to 70,000 children. Pre-K programs at two New York City Department of Education public schools located within two miles of the Museum participated in the Initiative: P.S. 84 and P.S. 111.

In seeking to engage two NYCDOE District Pre-K sites as part of the Initiative, the Museum met with administrative staff in charge of the NYCDOE early-childhood programs to learn about the goals for the Department for Pre-K across the City and within schools and to gain understanding of how best the Museum might help meet those goals. In addition, the Museum met with administrators from the NYCDOE STEM Initiatives Office to gain an understanding of the standards for early and elementary science learning and how the Initiative could support success.

NEW YORK CITY DEPARTMENT OF EDUCATION ROLE

NYCDOE advised the Museum early in the planning of the Initiative, including identifying which schools had Pre-K programs that might be suitable partners for the Initiative. Curriculum experts at NYCDOE advised on Pre-K content, standards, and approaches throughout the Initiative. Once the schools were selected, each school's principal, assistant principal, and participating teachers were integral to co-constructing the professional learning, family engagement, and visits to the Museum.

P.S. 111—The Adolph S. Ochs School

P.S. 111 is a Pre-K–5 public elementary school located in New York City's Hell's Kitchen neighborhood on the West Side of Manhattan. The neighborhood has experienced demographic changes in recent years, which has resulted in a school community including a range of socioeconomic backgrounds. In the 2017–2018 school year there were 349 students enrolled in the entire school (including 46 in Pre-K): 60 percent of the total students qualify as low-income; 14 percent are English Language Learners; and 23 percent have special needs. Forty-nine percent of students identify as Hispanic or Latino, 17 percent Asian, 15 percent white; 15 percent black or African-American, and 3% mixed races.

P.S. 111's constituencies work cooperatively to create a positive learning environment for all students. Their 2017 Comprehensive Education plan states, "Our community works diligently to teach the whole child so that he/she develops a strong sense of self, an ability to work with any community, and the critical thinking skills that are required to make good choices in the academic and non-academic world." The school emphasizes its support of hands-on learning and differentiated instruction. It prioritizes collaborative teaching through support of the lesson study format. Teachers facilitate small-group work with students to ensure individualized attention and to match the pace of instruction to each student's abilities. The school has three classrooms of Pre-K learners, with a total Pre-K enrollment of 46 children.

P.S. 111's approach to Pre-K values social and emotional development. The school uses the New York City Department of Education Pre-K curriculum materials—the **Pre-K for All Interdisciplinary Units of Study.** Units of study include transportation, light, water, plants, the five senses, and babies. The school also uses the **Building Blocks** curriculum to build math skills through games, artwork, songs, and puzzles that allow for play-based learning. Children spend most

of their day in small groups or with a partner learning through play-based experiences that revolve around thematic "centers": a play center, a dramatic center, an art center, and a reading center. P.S. 111 Pre-K teachers use the **Work Sampling System** as an early-childhood assessment tool that allows teachers to evaluate the skills of children as young as three. A series of evaluations allows young learners to demonstrate what they know, and allows their teachers to make informed decisions about how to guide instruction.

P.S. 111 invites parent participation in various ways. Parents are encouraged to participate in the Parent Teacher Association. At monthly Family Fridays, parents are invited to join their children's classes and participate in the first activity of the day. The school also has an open-door policy in the mornings. Parents can walk into the classroom and stay for a few minutes every morning to speak to the teacher and get an idea of what is going on in the classroom and the school. When time allows, parents can volunteer to create props or items that can be used in lessons. In the 2017-2018 school year, one parent helped create a transportation center in the Pre-K classroom, building a model plane for children to play in and learn from. One hundred percent of P.S. 111 Pre-K parents surveyed say that their child's teacher gives them helpful ideas of how to support their child's learning.

P.S. 111 ROLE

P.S. 111's leadership was enthusiastic about joining the Initiative because of the school's emphasis on supporting both family participation and teachers' professional learning and collaboration opportunities. Because P.S. 111 was a key site for the project activities, teachers at the school co-developed the professional-learning program with Museum staff. P.S. 111 leadership supported its Pre-K families to participate in all family activities. P.S. 111's Pre-K science resources were minimal, so leaders and teachers at the school were eager to collaborate on finding ways to make science a more integral part of early learning.

P.S. 111'S HOLISTIC PHILOSOPHY

Instruction is customized, inclusive, motivating, and aligned to the Common Core Learning Standards. High standards are set in every classroom. Students are actively engaged in ambitious intellectual activity and developing critical thinking skills. School leadership is committed to bringing resources from the community into the school building by welcoming, encouraging, and developing partnerships with families, businesses, and community-based organizations, with everyone working toward the shared goal of student outcomes.

P.S. 84—The Lillian Weber School

P.S. 84 first opened its doors in 1964. Located in Manhattan's Upper West Side neighborhood, the school is footsteps away from Central Park. The school had a total enrollment of 652 (including 105 Pre-K) students for the 2017–2018 school year. 4 percent of whom identified as Asian, 9 percent black or African-American, 38 percent Hispanic or Latino, and 44 percent white. Students with special needs make up 17 percent of the school population.

P.S. 84 leaders strive to make the community feel like family and thus encourage collaboration among students, faculty, staff, and parents to ensure all students are excelling through the rigor of the academic program. P.S. 84 has its own bimonthly podcast for parents, called "84's Podcast," which school administrators use to broadcast information to the school community, sharing announcements and advice on topics like internet safety, preventing tantrums in young kids, cooking healthy foods for families, and getting into middle school. The school hosts an engineering night twice each year for parents to attend with their children.

P.S. 84 has 108 children enrolled in the school's six no-cost, full-day Pre-K classrooms as a part of New York City's Universal Pre-K Program. The school expanded their Pre-K program from just two classrooms in 2016-2017 to six classrooms in 2017–2018. P.S. 84 offers French and Spanish dual-language programs for students in kindergarten through fifth grade. In part due to the high demand for dual-language programs in New York City, the school maintains extensive waitlists for spots in the Pre-K program. The French program is growing in popularity, and another French dual-language class has been added in the lower grades. Each grade has one Spanish dual-language class and one English-only integrated co-teaching (ICT) class with two teachers and a mixture of general-education and special-needs children. The school also offers performing arts, visual arts, and music programs.

In P.S. 84 Pre-K classrooms, teachers are focused on providing opportunities for exploratory learning. To do that, they encourage children to engage in dramatic play and hands-on activities. The school follows the **Pre-K for All Interdisciplinary Units of Study** set by the New York City Department of Education. Units of study include transportation, light, water, plants, the five senses, and babies. The school also uses the **Building Blocks** curriculum to build math skills through games, artwork, songs, and puzzles that allow for play-based learning.

P.S. 84 has a hands-on science garden program called Urban Roots that provides students with the opportunity to engage with and learn about the produce and environment on the school's roof garden. Through the Urban Roots program, students also study the life cycle of insects by raising monarch butterflies, ladybugs, praying mantises, and tadpoles. Twice a year, P.S. 84 hosts a Family Engineering Night. Parents visit stations with their children and work through a series of challenges together, such as building a race car track with ramps or building structures with Legos. As parents work with their children, educators pose questions to guide their thinking.

P.S. 84 ROLE

P.S. 84's large Pre-K community of six classrooms and its existing structures for professional learning made it an ideal partner in the co-development of the active STEM learning plan for its faculty. The school's leadership played an integral role in ongoing evaluation and family engagement.

SCHOOL GARDEN PROGRAM MAKES P.S. 84 UNIQUE

P.S. 84 is the only school in Manhattan with the **Urban Roots Program**, an unusually rich science garden program that serves Pre-K through fifth grade. Children learn outdoors on the school's roof garden, plant and take care of vegetables and fruit, watch the growth, see peas climbing, watch tomatoes fruiting, observe cucumbers growing, and taste and eat what they have grown. The garden also serves as a habitat for the monarch butterflies the students raise from larvae as they study lifecycles.

100Kin10

100Kin10 emerged in 2011 after a national call to action by President Barack Obama to add 100,000 excellent STEM teachers to the country's public schools within 10 years. The Museum was one of the original partners to 100Kin10, which helped launch the Museum Masters of Arts in Teaching Earth Science program. With 28 founding partners, today 100Kin10 brings together more than 280 of the nation's top academic institutions, nonprofits, foundations, companies, and government agencies. It is on track to meet its deadline of supporting and retaining 100,000 new STEM teachers. More than just a coalition, 100Kin10 enlists the right mix of diverse and powerful organizations to make strong commitments; amplifies their capacity and impact through collaboration, learning, and funding; and catalyzes solutions to large-scale problems by leveraging the strength of the network and its resources. Together, this leads to the systemic change needed to provide all students with high-quality STEM learning.

100Kin10 put forth a call to action in response to the question: "How should we support teachers to create active STEM learning environments for young students across the country? (**100kin10**)" This Initiative uses the Museum assets to address that question as a complement to the Museum own interest in providing high-quality science-learning experiences for young children and families.

Partnership Roadmap

Implementing the Initiative

As the lead partner in the Models of Access initiative, the American Museum of Natural History was responsible for spearheading collaboration among key stakeholders to create an experience that supported meaningful early-childhood science learning. The Museum adapted the ADDIE model (e.g., Branch, 2009; Molenda, 2003) to be a modified version of the PADDIE model (e.g., Department of the Navy, 2010), which provides a framework commonly used for designing an instructional program and strategically iterating on it. The PADDIE acronym stands for planning, analysis, design, development, implementation, and evaluation; this model served as a series of steps in designing, analyzing, and understanding outcomes of the Initiative. The use of PADDIE allowed the Museum to nurture partnerships that centered the needs and expertise of all parties and to assess the extent to which the Initiative was able to achieve the Museum's initial objectives and find answers to the questions motivating the Initiative.

An overview of all of the Initiative's activities can be found in the **appendix**.

PLANNING

In the "planning" phase of the Initiative, the Museum first needed to identify partners. Selection of organizations and schools relied on three key factors: current relationship status with the Museum; proximity to the Museum, because the Museum is committed to reaching local community members; and the interest and support of leaders at the schools and organizations, because involved leaders would be more likely to nourish family engagement and educator development. Using these parameters, the Museum selected Bloomingdale Family Program, Goddard Riverside Community Center, P.S. 84 The Lillian Weber School of the Arts, and P.S. 111 Adolph S. Ochs as partners. Both community-based organizations were current partners with the Museum; P.S. 84 and P.S. 111 were recommended by DOE Division of Early Childhood Education, and were brought on as new partners.

Early in the project, also as part of the "planning" phase, the Museum team gathered relevant resources. These included the Museum's prior work in early-childhood science; research from the fields of early childhood, science education, and museum learning; and information gathered in conversations with partner sites.

ANALYSIS

During the next phase of PADDIE, "analysis," the Museum—along with administrators and educators from each partner site—explored the following variables that contribute to children's learning experiences (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003):

- State and local policy initiatives (i.e., Universal Pre-K)
- Instructional approaches and assessments (e.g., High Scope, Creative Curriculum, DOE's PreK Units of Study)
- Individual classroom dynamics (i.e., teacher philosophies and environmental setup)
- School approaches to family engagement (e.g., social media, parent meetings, etc.)
- Teacher opportunities for planning, collaborating, and reflecting
- School philosophies

The Museum hosted a formal launch meeting of the Initiative. In attendance were leaders from the Museum, 100Kin10, the Division of Early Childhood Education of the NYCDOE, the STEM Office of NYCDOE, P.S. 111, P.S. 84, Bloomingdale Family Program, and GRHS. The goals of the launch were to create a community of partners by sharing early-childhood and STEM–related understandings and philosophies, and to introduce our proposal for a responsive approach to the partnership, which was influenced by the insights gleaned from earlier conversations with each site.

INTERIM ANALYSIS FINDING: LEADERS HAD DIFFERENT THOUGHTS ON "STEM"

Clear divisions among the educators on the meaning of the term "STEM" and STEM's use among early learners emerged during the launch meeting. For some, interdisciplinary STEM learning was not a viable goal for early-childhood learners. Some felt strongly that science learning with a focus on the natural world and on practices of science were a more authentic focus for young children. By the end of the launch meeting it was clear that there was a variety of interpretations of the term "STEM" and variability in rationale for why and how it should be incorporated into early-childhood learning.

The Museum also had the chance to observe Pre-K partners teaching in their own classrooms. From the beginning, the Museum wanted to understand Pre-K teachers' environments, styles, and philosophies, so as to bring them into the professional-learning sessions.

DESIGN

The design of the Initiative was informed by the outcomes of the planning and analysis stages, and was also grounded in an understanding of the children ultimately served through the work. Bronfenbrenner (2005) describes concepts of process, person, context, and time to construct a theory of human development. His earlier work, which informed the later theory, closely examined the concept of "context" and the way in which children learn through their social and physical interactions with the environment in which they live (Bronfenbrenner, 1979). While the work of the Initiative acknowledges the sophistication and importance of Bronfenbrenner's later concepts relating to human development, there was utility in leveraging his earlier description of children's context and the role it plays in development (Bronfenbrenner, 1979) to identify key individuals and institutions to include in the Initiative. In order to be mindful of the influence of children's context and the interactions they have in the places they live and learn, the partnerships developed through the Initiative were strategically designed to not only to support early childhood teachers' capacity to learn and teach science, but also to engage family members and administrators. **Figure 1** shows a very simplified version of the contexts in which children are situated and those that informed the work of this Initiative. While a change in one layer has the potential to ripple throughout the other layers, including parties within multiple layers creates vision alignment and increases the possibility of reaching the child.

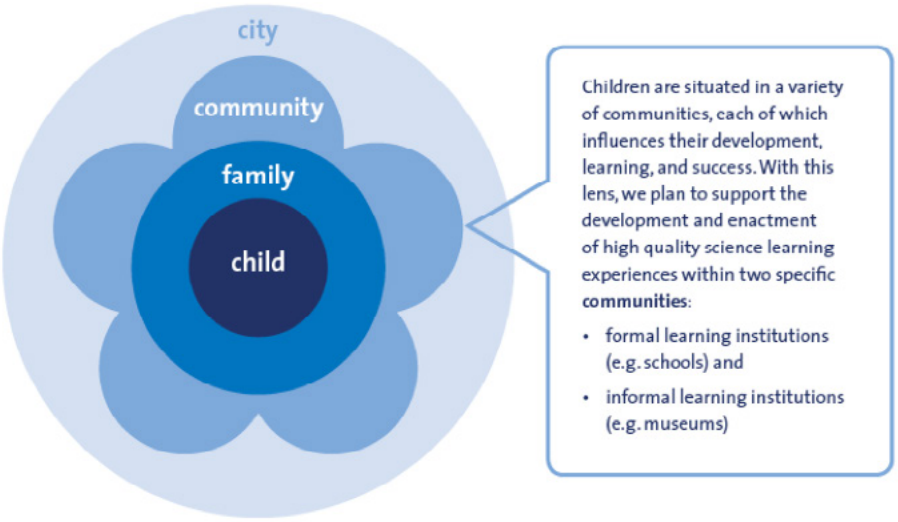


FIGURE 1. *Informed by Bronfenbrenner's Ecological Systems Theory (1994), this diagram depicts the importance of family and community when designing learning experiences for young children.*

With this in mind, the partnership was founded on three types of experiences (non-hierarchical), each with unique objectives meant to achieve the goal of the Initiative. **Table 1** below highlights the activities and experiences for administrators, teachers, and families surrounding the children in the Initiative as well as the overall objectives for those experiences.

Table 1: Project Activities or Experiences and the Objectives Addressed

While all four sites participated in these experiences, there were varying levels of engagement, as a function of the Initiative's responsive design. For example, GRHS had more opportunities for parent/child learning, while Bloomingdale, P.S. 84, and P.S. 111 experienced greater touchpoints with teachers. Deviances in the model for each site will be detailed further below.

ACTIVITIES/EXPERIENCE	OBJECTIVES
Administrative Communications	Administration supports Pre-K teachers' instructional practices involving inquiry-based learning and teaching in science.
Teacher Professional-Learning Sessions	Pre-K teachers engage in authentic and active science learning for their own content development. • Pre-K teachers use strategies for engaging adult learning partners (e.g. parents) in their children's science learning. • Pre-K teachers design active science learning experiences for children at school and at the Museum. • Pre-K teachers reflect on their science teaching and learning to inform their planning and enacting of learning experiences at school and at the Museum.
Parent and Family Engagement	Partners create and implement engagement opportunities at the Museum throughout the year for children, families, and school communities.

The Museum presented the design to partner sites and provided opportunities for feedback and revision. Once all parties were in agreement, the Museum signed a memorandum of understanding (**MOU; sample available in the Appendix**) with each institution. The agreement included, but was not limited to

- Dates for administrator communications, professional-learning sessions, and family engagement experiences
- Research, evaluation, and communication terms
- Allocation of $3,000 stipends for use by sites for substitutes, materials, or resources that might support the work of the partnership
- Information on transportation to and from the Museum on buses with car seats
- Language outlining the goals of the partnership and objectives for the professional learning experiences

DEVELOPMENT AND IMPLEMENTATION

With measurable objectives and an agreed-upon model, the Museum enacted the development phase of PADDIE by producing materials for the teacher and parent/child learning experiences, and implemented the project.

Administrative Communications

Quarterly meetings with administrators were scheduled at their respective sites. The Museum met with administrators to ensure vision alignment, receive insights into how the site was adapting to the Initiative, and discern whether changes should be made to better meet the needs of the sites. All partner leaders came together twice, once at the beginning of the year for a launch, and again at the end for a reconvening. Additionally, the Museum staff were available as needed for unscheduled phone calls, emails, and in-person meetings. The Museum aimed to establish a relationship that valued all parties voices by being accessible and responsive. Administrators from the partner sites were also invited to join all professional-learning sessions.

Professional Learning

The Museum developed opportunities that would nurture communities of practice (Lave & Wenger, 1991), honor the expertise of Pre-K teachers, and support teachers' growth as educators of early-childhood science. Professional-learning sessions were held both at the Museum and at the four different sites (depending on school requirements and teacher time). Over the course of the year, learning experiences for teachers surpassed the minimum recommended number of contact hours for professional learning over a sustained period of time (Desimone, 2009), reaching over 20 hours per site.

Sessions with teachers leveraged practices for building and sustaining professional-learning communities and supporting teacher content and pedagogy. The Science Immersion Model for Professional Learning (SIMPL) functioned as a foundational structure for Museum's professional-learning sessions. Similar to Bronfenbrenner's (1979) Ecological Systems Theory, SIMPL (Lauffer, 2010) supports the idea that children are embedded within and influenced by a system. SIMPL, therefore, is designed based on the idea that "high-quality and coherent science teaching and learning is supported when all learners throughout the system experience well-aligned learning opportunities" (Mundry, 2009, p. 61).

SIMPL PROVIDES A FRAMEWORK FOR A LEARNING CYCLE DESIGNED FOR TEACHER PROFESSIONAL LEARNING. IT INVOLVES THREE STEPS:

1. Surfacing teachers' prior ideas by engaging teachers in activities that allow them to document or share thoughts about content that will be discussed in the professional-learning session (teachers as teachers—engage and elicit)
2. Engaging teachers in a learning experience that provides them with the opportunity to learn a concept as their students might in their classroom (teachers as students—engage, elicit, explore, explain, and reflect)
3. Reflecting with teachers upon the rationale, objectives, and activities of the lesson to identify and inform how they might take what they have learned and apply it to their teaching practice (teachers as teachers— explain and reflect). **See Figure 2: Science Immersion Model for Professional Learning.**

Using SIMPL and being mindful of the ways in which young children learn, each professional-learning session was developed to build early-childhood teachers' science-content knowledge and pedagogical knowledge. To do this, opportunities were provided for teachers to engage in science learning within both the school and Museum contexts (teachers as learners), as well as to reflect on their own teaching and learning and to collaborate on planning lessons for their students (teachers as teachers).

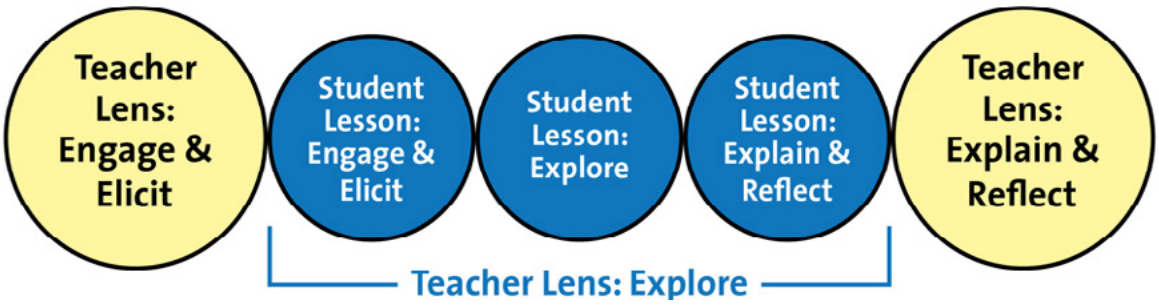


Figure 2. *Science Immersion Model for Professional Learning.*

TEACHERS LEARNED THROUGH THEIR OWN MUSEUM EXPERIENCES

Before bringing children to the Museum, teachers got a chance to preview the active science-learning experiences they would be leading with their classes by doing the activities themselves at the Teacher Professional-Learning Sessions with guidance from Museum staff. For example, when preparing for a unit on culture, teachers toured the Museum mask collection from the Pacific Peoples exhibit. Together, they considered what the masks on display might have been used for, what materials they were made from, and what signs and symbols they presented. Teachers then created their own masks that would serve as a reflection of themselves and their culture. At the end of the Teacher Learning Session, teachers convened with Museum staff to discuss which parts of the Museum collection they might use to teach their students about culture. Museum facilitators noticed a growing sense of confidence in the teachers throughout the school year as they attended these learning sessions. Teachers began to ask more questions in each session—without qualifying their questions with an apology for taking up time. The teachers' competency and sense of mastery continued to improve with each professional-development opportunity throughout the experience.

A sample of a professional-learning plan can be found in the **Appendix**.

PROFESSIONAL LEARNING AT THE MUSEUM AND IN SCHOOLS

The resources of the Museum were brought on teacher learning in all professional-learning sessions; however, some of the sessions were held at the school sites and some were held at the Museum. For Bloomingdale Family Program, it was difficult to get substitute teachers, so some professional-learning sessions were held during naptime. For P.S. 84, it was useful to have Museum educators work alongside NYCDOE Pre-K coaches, so both joined in Pre-K teachers' common planning time at the school. Bringing objects and specimens from the Museum to the school sites supported teachers' vision of what might be possible in their classrooms. It was important to have teachers come to the Museum for professional learning as well, allowing them to experience and learn within the Halls and Special Exhibitions that would be made available to their young learners and their families on class trips. Holding professional-learning sessions at school and at the Museum was intended to facilitate the teachers' learning about how to integrate science learning from outside of school contexts into their curriculum.

To ensure teachers would continue to learn along a focused trajectory, each professional-learning experience was in support of meeting one or more of the professional-learning objectives. Additionally, sessions were aligned with each partner site's curriculum and concentrated on relevant science-content themes. While the curricular plan of the sites varied, there were similarities in the early-childhood science content from which the Museum was able to draw. For example, the sites began the year engaged in professional-learning sessions focused on the content and pedagogy of science phenomena relating to senses (e.g., body senses of humans and animals; use of senses for observation).

Another key feature of the professional learning was the use of exemplary active and authentic science learning. In order to learn the science content, educators engaged in learning experiences that involved actively doing science or actively doing activities and participating in conversations to make sense of their experiences. These activities and investigations supported educators in building their understanding of natural phenomena (e.g., ways in which organisms sense their environment). Use of the SIMPL model (Lauffer, 2010) supported educators engaging in active and authentic learning, and also determining ways in which their learning experiences have implications for their young learners.

DEFINING ACTIVE AND AUTHENTIC LEARNING

In the objectives, we point toward "active" science learning and "authentic" science learning as processes for gaining content knowledge. Active science learning occurs when participants engage in learning activities that involve surfacing prior knowledge, making connections, critical thinking, problem solving, dialogue, idea synthesizing, and a variety of other "minds-on" experiences that drive participants to new understandings about science content. Authentic science is also active, but the term refers specifically to moments when participants are doing science as scientists do by engaging in science practices as defined in the Framework for Science Education (National Research Council, 2012), such as asking questions, analyzing and interpreting data, or planning and carrying out investigations. Both active and authentic science learning need to take place in schools for children to learn about science phenomena and engage in science practice to understand the nature of science.

In order to maintain coherence during the year, teachers co-generated a list of "Characteristics of Quality Early-Childhood STEM" with Museum educators. In this context, Museum educators clarified for teachers that learning within the partnership would be focused on the science discipline, but that this discipline was not fully discrete; rather, it would work in concert with other STEM disciplines. As a result, teachers at each site worked with Museum educators to create a list of characteristics they believed represented quality early-childhood STEM learning. The list evolved with each new session through the year. Museum educators visited teachers at their schools to observe STEM learning and to identify some of the teachers' pedagogical approaches that could be adapted for use in the children's Museum visits. Designing learning and reflecting on STEM learning together allowed teachers and Museum educators to engage in teaching practices that were responsive to the needs of early learners and build on their experiences in meaningful ways.

Museum educators integrated general, not just science, best practices in early childhood teaching and learning as a feature all of the professional learning. Being mindful of children's development and the diversity of cultural and linguistic backgrounds of the children was essential given the demographics of the partners in the Initiative. This mindfulness involved Museum educators demonstrating for teachers—who were also culturally and linguistically diverse—how to employ strategies that accessed learners' funds of knowledge (Gonzalez, Moll, & Amanti, 2006) and built new learning on prior experiences. Museum educators also integrated activities that emphasized opportunities for play and exploration into the SIMPL model in order to ensure that teachers were deeply considering age-appropriate science learning experiences for the young learners in their classrooms.

To be inclusive of parties from across children's contexts (Bronfenbrenner, 1979), teachers in professional-learning sessions brainstormed ways of including parents in their classrooms. To further bridge connections across home, school, and the Museum, the Museum collaborated with teachers to design visits to the Museum for each teacher's young learners and families, as aligned with the early-childhood curricula used at the school sites (e.g., Garet, Porter, Desimone, Birman, & Yoon, 2001; Guskey, 2003; Kennedy, 1998; NAEYC, 1993; Piasta, Logan, Pelatti, Capps, & Petrill, 2015; Wayne, Yoon, Zhu, Cronen & Garet, 2008; Yoon et al, 2007). Museum staff from the Children and Family Learning Program facilitated the class visits. Depending on the early-childhood partners' comfort levels, teachers were invited to co-facilitate or fully facilitate components of the class visit. The structure of Museum class visits is outlined in the family engagement section below.

STRUCTURE AND CONTENT OF CLASS VISITS AND PROFESSIONAL LEARNING

- ***GRHS:*** GRHS had more opportunities than the other sites for family engagement. Because of a partnership with the Museum initially established in 1998, classes visited the Museum 22 times throughout the year. Content for GRHS deviated the most from other sites, as the Museum needed to be responsive to GRHS's annual thematic calendar (**Appendix**) and to integrate family engagement more often, as had been the tradition of the partnership since it began in 1998. Professional-learning sessions, therefore, focused more on the Museum context.
- ***Bloomingdale, P.S. 111, and P.S. 84:*** These three sites all followed the same structure, which we came to refer to as a "two-cycle structure." The year was split into two cycles, each consisting of professional-learning sessions, one class visit to the Museum, and one reflection session. Reflection sessions are further discussed in our evaluation phase. Each cycle followed a different theme: "senses" in the first cycle and "change and transformation" in the second. These themes were chosen because all three sites explored the content topics in their classrooms. The two-cycle structure provided the Museum with a moment to pause after cycle one, reflect with all partners, and make changes to the following cycle as needed.

DETOURS ON THE ROAD: VARIATIONS IN IMPLEMENTATION ACROSS SITES

- GRHS and Bloomingdale Family Program teachers had a hard time getting to the museum for professional learning especially in the fall because of schedule conflicts and staffing needs at their sites.
- By spring, DOE sites were able to merge and meet for professional learning experiences together. The Museum conducted two full days of the same professional learning content so that co-teachers could come on different days and make sure that children had at least one of their usual teachers back at school while the other was out.
- DOE teachers received professional support from DOE central or their school administrators that complemented or supported what they were learning at the Museum (e.g. At P.S. 84 teachers had a professional learning coach to help them work on teaching and curriculum; at both schools teachers had common planning time with their teaching team and co-teachers)
- Bloomingdale Family Program had coaches from other partnerships (e.g. a professional learning coach from Bank Street College for children's social-emotional learning and development), but they did not work in tandem with the Museum as P.S. 84's coaches did.
- GRHS was one of multiple Goddard Riverside Community Center sites:
  - The first two PDs were with all Goddard Riverside Community Center sites, not just 95th Street.
  - There was teacher turnover in the fall, and new teachers joined mid-year.
- P.S. 111 chose to go to Butterflies instead of Our Senses (different from 84 and BFP) for the "senses" class trip.

FAMILY ENGAGEMENT

Family engagement outside of the teachers' classrooms was woven into the Initiative in three ways: parent orientations, whole class visits, and Family Fun Nights.

Parent Orientations: At the beginning of the year, Museum staff visited each site to share details of the partnership with parents. This involved working with administrators to set up times to visit each school and speak with parents. Museum educators brought images of parent and child classes in the Science and Nature Program, some live organisms (e.g., walking sticks and cockroaches), and tickets for families to come to the Museum at their leisure. The orientation ran slightly differently at each site.

- ***GRHS:*** Museum educators attended a parent meeting, one that is regularly held with parents at the 95th Street GRHS site. Some parents who had been involved with the longstanding Museum partnership shared their experiences.
- ***Bloomingdale Family Program:*** Museum educators attended the parent orientation for the whole program. They sat with the Education Director, who shared an overview of what to expect at the school and then shared a bit about what the work with teachers would be and what to expect at a class visit. This was one stop for parents as they circulated, getting information about many aspects of the early learning their children would experience at Bloomingdale.
- ***P.S. 84:*** Parents joined Museum educators in the school's auditorium after school hours. The parent coordinator had notified families that the Museum educators would be there to share the work, but attendance was low.
- ***P.S. 111:*** Parents joined Museum educators in the school's cafeteria in the morning before school hours. Attendance was higher for P.S. 111 than for P.S. 84 even though P.S. 111 had half the number of Pre-K learners.

Whole Class Visits: Teacher learning experiences and collaboration helped to emphasize the importance of STEM in classroom learning, but additional activities were necessary to involve parents and build enthusiasm around STEM learning with children in the Museum and at home. Each of the partner schools brought all of their Pre-K classes to visit to the Museum. Unlike in field trips, every child came with a parent or grown-up as well as their classroom teachers. The Science and Nature Program at the Museum has traditionally been made up of parent-child classes, with the idea that parents facilitate and motivate their young children's learning. The GRHS partnership continued this model, with parents attending class weekly with their children all year. However, the Bloomingdale Family Program, P.S. 111, and P.S. 84 each made two class visits to the Museum with all the children and their parents in attendance. The idea was to provide the families with at least two structured, active STEM learning experiences at the Museum.

In each of the class visits, the teachers, the children, and a grown-up from each child's family participated in the same five learning experiences:

1. ***Introduction Rug Meeting:*** Museum educators gathered the children for a "rug meeting" conversation that connected the topic of the day to the children's prior knowledge.
2. ***Hall Visit:*** The class explored a Museum hall to make observations; to compare objects, organisms, or environments they saw; and to make connections using the observations to gain new understanding of the science topic of the day.
3. ***Reflection Rug Meeting:*** The children talked about their observations and experiences in the halls and discussed new ideas, connections and terminology.
4. ***Free Exploration:*** The children wandered around the Museum classroom with their parents, playing games, completing science puzzles, making science-related art, or observing live animals as each related to the topic of the lesson.
5. ***Feature Creature:*** A Museum educator with expertise handling live animals introduced an animal to demonstrate a phenomenon relating to the topic of the day . The children often handled the animal themselves and had a chance to ask questions and observe features or characteristics of the animal that further supported their learning.

The sequence of these experiences depended on what the children were learning and what seemed to be most appropriate for the class, as determined by the Museum educators and teachers together.

- ***GRHS:*** Each week for a total of 20 weeks, children in GRHS visited the Museum as a class. At the Museum, classes met in different exhibits related to the topic they were learning about that week. For example, while learning about rocks, the children explored the Museum Hall of Planet Earth, and teachers and parents asked them to describe the color, texture, and size of the rocks they saw. The children were also prompted to think about how scientists might have collected the rock samples. The class ended with a hands-on activity of selecting a rock and sharing with a neighbor what they noticed about its physical characteristics. Another week, the class learned about marine mammals at the Museum Hall of Ocean Life, where they compared teeth and baleen on the Museum squid and blue whale models. The lessons showcased the scope and variety of available science learning in the Museum. In addition, these visits allowed the Museum to function as an extension of the classroom and to enhance the children's overall learning experience in active STEM learning.
- ***Bloomingdale Family Program and P.S. 84:*** Pre-K classes from P.S. 84 and Bloomingdale visited the Museum twice over the course of the school year. During the first visit in the fall, classes visited the Museum special exhibition Our Senses as a way to introduce science to the children as a subject focused on studying not just on what they see, but also on what they taste, smell and feel. In the spring, the theme for the class visits was change and transformation. Classes visited the special exhibit Unseen Oceans to explore ocean habitats and animals, and the change and growth that occurs in and around them. Both visits were developed in alignment with the Pre-K curricular units.
- ***P.S. 111:*** Pre-K classes from P.S. 111 also visited the Museum twice. While P.S. 111 was also focused on senses, the teachers opted to visit the butterfly vivarium. Teachers felt the using butterflies to compare the senses of humans and insects connected better to their young learners, both in content and developmentally. In the spring, classes visited the special exhibition Unseen Oceans.

Family Fun Nights: Finally, to demonstrate a commitment to the families at all the institutions and to build enthusiasm for learning STEM as families at the Museum, the Museum organized "Family Fun Nights." The Museum closed down the fourth floor halls after regular hours, served snacks, and set up learning stations, allowing families to explore and learn together in a safe, fun, and community-focused environment. Family Fun Nights were not in the initial plan for the Initiative, but were born out of the desire to give families unique, fun, unstructured, and shared learning experiences at the Museum that would inspire future science learning at home and encourage families to view the Museum as a resource for lifelong learning. The Family Fun Nights allowed whole families, including both parents, siblings, grandparents, etc., to participate in the learning together outside of typical school and work hours—unlike the class visits, which were held in the mornings.

FAMILY FUN NIGHTS

To showcase all the Museum had to offer at an after-hours Museum tour and to spur STEM-focused conversations and engagement between parents and their children, the Museum created a "Passport" with a guide of activities and prompts for Family Fun Night. For example, at The Titanosaur, one of the the largest dinosaurs on display in the world, parents helped children measure the size of the dinosaur by counting the number of steps it took to walk its length and asked, "How many steps did you take from the dinosaur's head to the base of its neck?" This type of interactive family activity is a valuable opportunity for families to immerse themselves in active science learning and teaching at the Museum.

EVALUATION AND RESEARCH

Through PADDIE (Branch, 2009; Department of the Navy, 2010; Molenda, 2003), the Museum designed, developed, and implemented a responsive model for the Initiative. While "evaluation" is the last step listed in the acronym PADDIE, the Museum evaluated its work at every step in the development and enactment of the Initiative, to better understand needs for adjustments along the way. A postdoctoral fellow at the Museum and Museum educators conducted both informal and formal evaluation throughout the year to support responsiveness. All assessment data and materials were collected and then were discussed, considered, and applied to the model at every point throughout the Initiative.

Administrator Feedback

Throughout the year, the Museum discussed the movement of the project with site administrators. Through conversations, the model was analyzed and, if necessary, modified to better meet the needs of each site. For example, administrators at Bloomingdale shared the constraints of finding substitute personnel when teachers attended professional-learning sessions at the Museum. To continue engagement and support all teachers, the Museum pivoted to facilitating sessions during student naptime at Bloomingdale. Half of the teachers would attend one day, while the other half would attend the next.

A culminating convening facilitated by the Museum served as a formal opportunity for partner site leaders to provide feedback on the Initiative. This convening involved all partners and came at the end the Initiative's implementation phase. Leaders shared their experiences, perceptions of teachers and of family engagement and impact, and ideas for how to ensure that future initiatives better support their communities.

Teacher Feedback

Each professional-learning session was designed to be collaborative and to actively engage teachers in learning, reflecting, and planning together. Museum facilitators were able to collect anecdotes and artifacts produced by teachers throughout the Initiative. Following each session, Museum facilitators would reflect on the experience using their informal observations and the artifacts collected to inform the development of the subsequent professional-learning session.

More formally, early-childhood teachers were asked to complete a feedback form at the end of every professional learning session. The evaluation form **(appendix)** asked teachers to reflect on their learning, describe what supported their thinking the most and the least, and to provide any other notes for the Museum to consider. The forms provided the Museum with some understanding of each educator's thought processes, learning styles, needs, and desires, which was then used to inform the development of future sessions.

Additionally, the Museum held a reflection session at each site after each cycle, Fall and Spring. Questions that guided each reflection session can be found in the **appendix**. The reflection sessions served as crucial checkpoints between and after cycles, eliciting information that could be applied to a future cycle, while the program still adhered to the same general cycle structure.

Family Feedback

Family members who attended orientations, class visits, or Family Fun Nights shared stories, pictures, and children's work with their school administrators, teachers, and Museum educators.
Select parents were interviewed at the end of the year to understand their experiences with the Initiative and their perceptions of their children's experiences.

Research Along the Way

Qualitative research was conducted to document the experiences of Pre-K educators, early learners, and parents and families through the partnership experience. A postdoctoral researcher on staff at the Museum conducted observations of professional-learning sessions and classroom teaching, teacher interviews, and focus groups to understand teachers' experiences. The researcher documented observations through ethnographic field notes, audio recordings of teacher discussions, and images of professional-learning activities and classroom environments. When children and families came to visit the museum, observations were documented by the researcher to understand their experiences learning together. Data analysis included open coding of field notes, transcripts of audio recordings, interviews, and focus groups (Charmaz, 2014) and the use of thematic and integrative memos (Emerson, Fretz, & Shaw, 2011) to generate findings.

Insights

In this section, insights are highlighted to show what the Museum staff and researchers learned through the duration of the project. The Museum staff and researchers examined the potential for these partnerships to support active and authentic science learning for early learners at the Museum, in school and at home in relation to the questions that inspired the Initiative from its onset:

1. In what ways might institutional partnerships provide opportunities for greater numbers of early learners to gain access to quality early-childhood science learning?
2. What can we identify as meaningful learning experiences, learning environments, and content resources to support early-childhood teachers to become confident educators of science and to gain the skills and knowledge that can give young learners strong science foundations?
3. What does science learning look like for young children and families?

These guiding questions are addressed below, along with specific examples and recommendations for others who seek strategies or interventions for enhancing early science learning.

IN WHAT WAYS MIGHT INSTITUTIONAL PARTNERSHIPS PROVIDE OPPORTUNITIES FOR GREATER NUMBERS OF EARLY LEARNERS TO GAIN ACCESS TO QUALITY EARLY-CHILDHOOD SCIENCE LEARNING?

By sharing a common focus of early-childhood science learning, partnerships between an informal science institution and institutions with Pre-K classes amplified science as a priority for participating organizations.

There were several opportunities to connect with leaders from partner institutions, as described in the **Section IV: Partnership Roadmap**. Leaders from the respective partner institutions met in two convenings where they learned about one another's work in early childhood. Convening with Head Starts and NYCDOE schools offered opportunity for cross-institution community-building and generative conversation about early science learning in different contexts. In these convenings leaders shared many ways their institutions, teachers, and families derived value from their partnerships with the Museum. They shared with one another the ways in which early science learning gained attention and was celebrated through the partnership activities of teachers, Pre-K classes, and families. For P.S. 84, the early science focus

supported Pre-K bonding and collaboration in lesson planning as the school expanded the number of Pre-K classes from two to six in the 2017–2018 school year. The administrator from Goddard Riverside discussed her teachers' excitement at the idea of using live animals for teaching science in their classrooms and noted that the school was interested in creating a museum-like environment in one of their vacant classroom spaces. Administrators from P.S. 111 expressed a desire to enhance classroom science centers and were enthusiastic about this Initiative supporting that enhancement. Bloomingdale administrators noted that their teachers were developing their own enthusiasm for science, and that the enthusiasm could be seen in their classrooms and staff meetings. Administrators and, when available, parent coordinators from all the sites worked with families to heighten awareness of the partnership and encourage parent participation in class visits and attendance at Family Fun Nights. These positive responses to the Initiative suggest that the community values science and welcomes the discipline as a focus for partnerships working to enrich early-childhood education. Hence it was demonstrated that this focus enabled the partner communities to bond and develop their early science-learning capacities.

Recommendation: Because sharing a common focus such as early-childhood science creates a sense of community and elevates opportunities to talk about that focus, the focus becomes a priority for partners. We recommend having administrators from partner institutions participate in conversations with one another about early-childhood science at least once a year and with the leadership from the Museum at least monthly throughout the partnership to maintain the focus on early-childhood science and keep it a priority for Pre-K at their institution.

Selecting partners with supportive leadership from each of the institutions enabled teachers to transfer their professional-learning experiences to the classroom.

Administrators of institutions in this Initiative did not merely say they were excited about pursuing a partnership to enhance science education in their Pre-K classes; they took action at their school sites to ensure that teachers, aides, and paraprofessionals were able to join in professional learning with Museum educators, were able to collaborate with one another, and were implementing their learning with their young learners. Administrators from the NYCDOE schools secured substitute teachers for days when their Pre-K staff were on site at the Museum. At the community-based organizations, they arranged a meeting place for teachers to get together during the children's naptime to discuss science learning and planning for the Museum visit and offered time during their scheduled staff development days to use for professional learning at the Museum. The Pre-K staff developer assigned to P.S. 84 from the NYCDOE used the team's common planning time to discuss how they could use their excitement and new learning about science and integrate it into the Pre-K Interdisciplinary Units of Study that they were required to teach. While research (Clements & Sarama, 2016) continues to show that literacy and numeracy are often given higher priority than science in early-childhood classrooms, the partner institutions in this Initiative made sure that teachers had time and space to plan and implement science in Pre-K at their sites.

Recommendation: Because professional learning takes time and needs to be directly applicable to and practiced in teachers' classrooms to be effective, administrators play a large role in ensuring that professional learning transfers to classroom practice. We recommend selecting partner institutions that have school leaders who "buy in" and will support the work at their school sites.

Family events and parent/child classes at the Museum served as opportunities for parents at partner institutions to be directly exposed to early-childhood science and encouraged their participation in their children's science learning.

Parents were invited to join in their young children's science learning at the Museum. Nearly all children had at least one parent join them to learn at the Museum when they came for class visits. Family Fun Nights at the Museum, designed specifically for families from partner schools, were highly attended and made it possible for siblings, grandparents, and other relatives to join in the science learning. These experiences were available to families from partner institutions as well and expanded the science-learning opportunities for young children beyond what the partner institutions could offer independently. Additionally, families happily accepted and requested complimentary tickets to attend the Museum

on their own, which suggests they were interested in furthering their children's science learning even more. Hosting a Family Fun Night event was a new element for all the partners. It served as a way to build families' enthusiasm about the partnership, to offer a fun family outing, and to expose families to the positive science experiences that the Museum fosters in its Halls. Families expressed feeling special since they had the Halls to themselves to share with their friends from school and extended family members. Families braved the weather to come out for these events: A snowstorm created the need to reschedule the Family Fun Night for DOE schools and also created somewhat prohibitive weather on the Family Fun Night for Bloomingdale.

Recommendation: Because parents are greatly influential in their children's learning, it is important to involve them directly in science learning with their children. We recommend creating science-learning opportunities explicitly for parents and children together.

Each model in the initiative has potential for positively influencing young children's access to high-quality early science learning.

Overall, the Initiative demonstrated promise for enriching early-childhood science through institutional partnerships. The models used with this outcome in mind varied among partner institutions, with GRHS continuing the same model that has been implemented since 1998 and with Bloomingdale Family Program, P.S. 111, and P.S. 84 using a newly developed model (see **program calendar**). Both models engaged children, families, and teachers in science learning at the Museum and increased young children's opportunities for science learning through the variety of activities of the Initiative.

The variation in structure (GRHS had 22 class visits and the other sites had two) and focus (Bloomingdale, P.S. 111, and P.S. 84 focused on teacher science learning and integration between science learning at the Museum and science learning in their classrooms and GRHS focused on children and family learning at the Museum) influenced how and when Museum staff were able to observe young learners and their families engaged in science learning. In the case of GRHS, Museum educators had several direct interactions with families, building relationships and a sense of community with parents, children, and teachers alike. Nearly all the families chose to continue on in the Museum Science and Nature Program for the 2018-2019 school year, when the children would be at many different schools and in kindergarten. The Museum direct contact with the families from the other sites was much more limited. Families had exposure to both structured and unstructured science learning within the Museum, but beyond limited positive feedback from parents during these visits from teachers and administrators afterward, the Museum received little information about the impact of the visits on the families and on their views of science and learning at the Museum.

For Bloomingdale Family Program, P.S. 111, and P.S. 84, the greatest influences of the Initiative was on teachers. In terms of numbers, the contrast between the models is large. One Pre-K class at GRHS had 16 children, whereas Bloomingdale Family Program had 60 children, P.S. 84 had 108, and P.S. 111 had 54 (see **Table 2: Partnership by the Numbers**). In sum, the GRHS partnership model increased the number of science-learning opportunities through classes directly provided by the Museum, whereas the partnership model used with the other three sites increased science-learning opportunities for young children through increased professional learning for teachers focused on early science learning in addition to unique science-learning experiences at the Museum for families that expanded the learning beyond what would typically happen at the school.

Table 2: Partnership by the Numbers

	GRHS	BLOOMINGDALE	PS 84	PS 111
PARTICIPANTS				
Teachers (4s only)*	4	10	13	6
Teachers (total including 2s and 3s)**	24	25	13	6
Children (4s)	16	60	108	54
Children (total including 2s and 3s)*	32	135	108	54
Family Fun Night Attendance	89	86	174	93
Children and Family classes at the Museum including Family Fun Nights	25	3	3	3
Professional-Learning Sessions for Teachers	7	9	8	8

**Teachers from all the Goddard Riverside Community Centers participated in at least three professional-learning sessions. Only two teachers of four-year-olds were part of the ongoing GRHS model that involved 22 class visits and included more professional learning. **Goddard Riverside and Bloomingdale included their Day Care classes in the Initiative, but the NYCDOE district schools only have Pre-K for All for four-year-olds.*

Recommendation: Because there are trade-offs in designing programs for large numbers of children and families versus smaller numbers, we recommend finding ways to do both. The model that emphasized professional learning for teachers raised the potential for more children to be exposed to high-quality early science learning in more settings, whereas the model that emphasized weekly family classes reached fewer children, but was able to provide deeper and more-foundational learning experiences.

WHAT CAN WE IDENTIFY AS MEANINGFUL LEARNING EXPERIENCES, LEARNING ENVIRONMENTS AND CONTENT RESOURCES TO SUPPORT EARLY-CHILDHOOD TEACHERS TO BECOME CONFIDENT EDUCATORS OF SCIENCE AND GAIN THE SKILLS AND KNOWLEDGE THAT CAN GIVE YOUNG LEARNERS STRONG SCIENCE FOUNDATIONS?

An essential component of the Initiative was the science professional learning for Pre-K educators that positioned teachers as learners of science, created time and space for reflection on personal practice, and leveraged the Museum's vast collections and assets. In this section, insights about this approach to professional learning and its role in the partnership are articulated below. We examined this question in terms of the learning experiences, learning environments, and content resources utilized in teachers' professional learning.

Science Professional-Learning Experiences for Early-Childhood Teachers

The Initiative offered many strategically designed professional-learning experiences to help teachers build the knowledge and skills necessary to provide their young learners with strong science foundations. These learning experiences were developed to engage teachers in their own science learning by doing science at the Museum, and to situate teachers in a learning community of early-childhood colleagues and Museum educators, generating a shared and robust understanding of early-childhood science learning. Each of these emphases for teacher learning supported the teachers' knowledge about science and early-childhood science teaching and learning.

Learning Experiences Involved Doing Science

Some of the learning experiences developed in the Initiative engaged early-childhood teachers in doing science and participating in dialogue about science content with their peers. Using the SIMPL Model (Lauffer, 2010), as described in Section IV: Partnership Roadmap, meant teachers were frequently situated as learners of science during their professional-learning experiences. For example, teachers walked through the live butterflies exhibition while focusing on their sense of smell, observed the behavior of nightcrawler worms, or navigated the Rainforest in the Hall of Biodiversity to scrutinize the life of a single tree. These are some illustrations of how the professional-learning sessions positioned teachers as science learners. The Museum used many of the strategies for science teaching that are used in Museum-based early-childhood classes—observing and handling live animals, gathering data from Museum dioramas, and using science technologies such as microscopes—to engage teachers in science practices (NRC, 2012).

LEARNING EXPERIENCES: TEACHERS WERE SCIENCE LEARNERS AS THEY EXPLORED HUMAN BODY SENSES

The inaugural professional-learning session for all teachers explored the human senses. Teachers engaged in activities that were designed to challenge and expand their knowledge of the five senses: seeing, hearing, touching, smelling, and tasting. To model the partnership's approach to active learning, the teachers participate in a series of learning experiences that forced them to observe the way their senses responded to different stimuli. Teachers rotated in small groups to five different stations. At one station teachers ate Skittles of different flavors, first while holding their noses, then without holding their noses. This activity was meant to highlight the relationship between taste and olfactory senses. At another station teachers were asked to walk a path, first on their toes and then on their heels. Each of the stations was designed to be an activity that teachers could do with their own young learners.

After visiting each station, Pre-K teachers reflected on their experiences in the senses activity. They talked about what senses they used and when, how their definition or understanding of senses had changed, and what surprised them about the experience. The conversation elicited reactions like "senses trigger memories" and "we learned the importance of smell and how it affects the way we perceive taste." Teachers also explored how the senses work together to produce or limit understanding or experiences. Thus, the senses activity expanded the teachers' understanding of the boundaries of senses, shifting more traditional views of senses as singular to a much more nuanced understanding.

Such reflective conversations that build on the active learning experiences also created opportunities for Museum educators to support teachers in deepening their knowledge of science content and in thinking about how they might expand children's pedagogical experiences in their own classrooms.

The teachers then spent the later part of the same professional-learning session in the museum Discovery Room, a space in the Museum designed specifically for young children to explore and play. The teachers were asked to bring their expanded understanding of senses to bear on the activities in this space and generate new ideas for how they might engage their own young learners

When they learned about human senses, teachers were actively engaged in observation and sense-making to glean important insights about science content. They could then use this new understanding to make connections for the Pre-K learners in their own classrooms. To both learn and teach science, teachers needed to participate in learning experiences that would be consistent with the content and learning strategies they might employ with their young learners. Ultimately, this experience led to teachers gaining new understanding about human senses as they were concurrently teaching about senses, both as tools for observing and as they relate to human body functions, to their young learners at their school sites.

Teachers' professional learning in science should lead them to support their students to "learn to think and act like scientists" (NRC, 2007, p.13). To effectively do this in ways that reflect the recommendations of the Framework for Science Education (NRC, 2012), there has been a shift away from science as simply "hands-on" learning to engaging learners in the work and practices that scientists engage in to generate conceptual learning of science. For educators—like the Pre-K educators with whom the Museum partnered—this means "moving from science they might have experienced in schools—the science of baking soda volcanos and solar systems of Styrofoam balls—to science learning that is rooted in the exploration of phenomena, in the thinking and practices that scientists engage in, and where inquiry is emergent, not prescribed" (Furtak & Penuel, 2018, p. 169). To enact this change in school science learning, both teachers and children need opportunities to engage in science practices.

Pre-K educators in the Initiative had the opportunity to be learners themselves. They reflected that coming to the Museum was about learning—they felt like they were kids again—and it was such a rare feeling. At the Museum, they were encouraged to figuratively put on their "student hats" and enact the practices of scientists. Teachers framed their "student hat" experiences as freeing: They felt good about exploring, about sitting in a place of not knowing. This was intentionally built into the design of the professional learning to allow teachers time and space to learn for themselves and to enact science practices. Practice approaches to professional learning where teachers get to *do as the pupils do* (Hammerness et all, 2019) are increasingly being understood as a better way to support teachers in growing professionally and changing their pedagogical approaches and work with students (Ball & Forzani, 2009). In science education specifically, practice approaches to teacher professional learning are reflective of the demands of the Next Generation Science Standards that attempt to shift students' experiences to doing science and being engaged in the practices and epistemologies of scientists across a rich spectrum (cf Furtak & Penuel, 2018; NAP, 2017).

Recommendation: Because early-childhood educators often come to their position having had few positive experiences in their own learning of science, it is important to provide them with learning experiences that situate them as learners of science. We recommend engaging teachers in several learning experiences over time, using the SIMPL model and integrating play, that are relevant to the content they need to teach as part of their curriculum and are appropriate for teaching early learners.

LEARNING EXPERIENCES INVOLVED PARTICIPATING IN A COMMUNITY FOCUSED ON CO-GENERATING AN UNDERSTANDING OF EARLY-CHILDHOOD SCIENCE LEARNING

Using SIMPL (Lauffer, 2010) also situated teachers in a learning community. Their professional-learning experiences involved reflecting on their own science learning and teaching with their colleagues and Museum educators to co-create a shared understanding of early-childhood science learning and the ways in which their collective ideas could influence their classroom teaching. Within this learning community, learning experiences involved teachers spending a significant amount of time reflecting on their early-childhood teaching practice. Specifically, Pre-K teachers:

1. Reflected upon science practices in the everyday Pre-K learning experiences they facilitated in their classrooms
2. Made connections between science and other disciplines

LEARNING EXPERIENCES: TEACHERS REFLECTED TOGETHER ON CHARACTERISTICS OF HIGH-QUALITY EARLY-CHILDHOOD SCIENCE LEARNING

In order to foster shifts in perceptions of science and ways of integrating science into the early-childhood classroom, professional-learning sessions encouraged collaboratively reflecting on prior classroom lessons and on collectively designed new lessons. In the fall of 2018, Pre-K teachers were asked to bring photographs that illustrated science learning in their classrooms.

At the Museum, teachers participated in a connection-making process—by which they shared the photographs from their classrooms, explained to their peers what was going on, and then made links to the characteristics of early childhood science learning that they had developed with their peers in previous professional-learning sessions. In one session, a teaching team made up of two experienced early-childhood educators, shared a picture of their four-year-old learners making hot chocolate. Museum educators facilitated a discussion with the Pre-K teachers in the group that illuminated the science involved. This included: mixing two substances, a liquid and a solid; dissolving solids into a liquid; the role that heat played in absorbing the chocolate; and what happened if the milk was too tepid.

As the conversation unfolded, other teachers were able to make connections to their own classrooms, reconsidering other learning activities that they had not viewed as particularly scientific. Through this process they were able to apply a scientific lens to practices that were central to their early-childhood practices, such as cooking, taking walks in the neighborhood, and looking at objects from the observable world, including stones and leaves. The teachers worked together to closely examine their everyday classroom practices to see the deep scientific connections that were visible in many of them. Even though cooking had been thought of as scientific for obvious reasons—like the change in temperature—many other facets of this activity were not visible to the group until they explored this deeply together.

Many teachers had not considered cooking to be an opportunity for science exploration, but this teacher's documentation started conversations that expanded their understanding of what science learning is and where it can happen. As a group, the educators discussed science principles they could observe and explore while cooking with children, such as heat and evaporation. Discussing these activities during the reflection sessions created space for Museum staff and educators to explore and recognize together how expansive science learning and content are. They reflected that science learning is not limited to those finite concepts within a textbook, but can be as simple as making observations about surroundings and trying to understand the how and the why of various situations and phenomena.

By reflecting on their own practices with one another and with Museum educators, about the characteristics of high-quality science learning, teachers were able to collaboratively engage in a metacognitive exploration of how early-childhood learning activities they were already doing in their classrooms were deeply scientific. During the time that was allocated during professional-learning sessions for reflection and design, teachers developed new understandings of "doing science" and "seeing science" in their classrooms. These experiences shifted preconceptions about science as a discipline made up of complicated experiments and sets of facts, and shifted the teachers closer to identifying science as something that one does to understand natural phenomena.

Recommendation: Because teachers are more likely to apply their professional learning to their classroom when it is grounded in their day-to-day teaching practice (Putnam and Borko, 2000), it is useful to situate teachers in a learning community where they are able to discuss their own teaching and learning experiences and generate understandings together. We recommend professional-learning experiences that allow teachers to contribute specific examples of science teaching and learning from their own early-childhood classrooms, which can be used to come to common ideas about best practices in early-childhood science.

SCIENCE-LEARNING ENVIRONMENTS FOR EARLY-CHILDHOOD TEACHERS

Museum assets and Museum learning environments were significant inspiration for early-childhood teachers in this Initiative. Each time teachers visited these Museum classroom spaces, they made note of materials in the learning environment that they thought their young learners would enjoy. Additionally, their exposure to the live animal collections in the Museum classrooms motivated them to adopt pets in their own classrooms. Teachers learned strategies for observing, asking questions, making predictions, and sense-making in the Museum classrooms, exhibitions, and Halls; they then used those strategies by having their young learners examine how local trees change through the seasons, observed class pets and how they responded to different stimuli, and even as they cooked, painted, and played.

LEARNING ENVIRONMENTS: TEACHERS GAINED COMFORT TEACHING SCIENCE IN AND OUT OF THEIR CLASSROOMS

In the spring of 2018, a group of Pre-K teachers attended a professional learning developed around the theme of change and transformation in the natural world. That afternoon, they visited the Rainforest exhibit, a small, dim space that emulates the dense, dark lower layers of the Dzanga-Sangha rainforest in the Central African Republic. There they were tasked with observing and documenting the nature of change by focusing on a single tree. With flashlights in hand, the teachers looked from the roots upward, observing all the small and large animal and plant life surrounding just one tree trunk. They also stopped to read the placards, watch some of the short films, and flip through a book of species that are displayed in the exhibit, all of which detailed some of the ongoing challenges of maintaining the animals in the rainforest due to deforestation and hunting as well as issues from industries like diamond mining.

As the Pre-K teachers were exploring the rainforest, a group of fourth grade students from a local public school bounded into the exhibit. Although eager to explore, the fourth graders found it difficult to see very much in the dim light. The PreK teacher partners, noticing this, started to work with the fourth grade students who did not have flashlights. The teachers pointed their flashlights up and down to illuminate the monkeys high in the trees, the beetles and butterflies on the forest floor, and everything in between.

This impromptu moment illustrated how the Pre-K teachers had become more comfortable with navigating a museum exhibit. They leveraged their own experiences navigating the various museum halls to show young learners how to use the halls for their own learning.

As part of the professional-learning experiences, teachers visited the special exhibits and halls before their class visits—as learners. They looked, wondered, and asked questions as their students might. When it was time to reflect on what might be challenging or pose opportunities for their Pre-K children and families, teachers were able to draw on their own experiences as learners navigating the special exhibits and collections to make informed decisions about how to utilize these spaces for learning. They also considered where and how parents could support their children in learning. This ranged from practical support (e.g. lifting kids up to see some of the displays) to the more abstract support (e.g. asking questions about or making connections to the science content observable or described in various parts of the hall). These “pre-trip” visits also helped Pre-K teachers to determine what big ideas about science they wanted to convey, how to make connections to their students’ own lived experiences, and how to develop and embed museum learning into their classrooms.

Recommendation: Because informal science institutions provide learning environments unlike classrooms, early-childhood teachers can be inspired and engaged in science learning in novel and authentic ways. We recommend using the informal institution as a catalyst by exposing early-childhood teachers to a variety of learning environments within informal science institutions and explicitly supporting them in considering how their learning experiences at the informal science institution could inform their decisions in selecting and designing learning environments for young children.

EXPOSING EARLY-CHILDHOOD TEACHERS TO SCIENCE CONTENT RESOURCES

The Museum has a plethora of objects, dioramas, living organisms, and tools for scientific research in addition to expertise in science and science education. These assets afford a variety of opportunities for learners of all ages to engage in science practices and generate new understandings about science content. An important intention of the Initiative was to utilize the rich content resources to nurture teachers' science learning and to find ways to support teachers in identifying how to access and use these content resources with their own students. Teachers became acquainted with new resources and activities through exposure to the Museum classrooms and through opportunities to leverage Museum assets in their own teaching.

When teachers visited the Museum with their classes for the first class visit, they had an opportunity to observe the Museum educators teaching a science lesson. They were able to see how Museum educators leveraged the Museum collections—which included a range of materials and resources like replicas of animals and insects preserved in amber—in activities related to the life cycle of plants or animals, for example. Moreover, teachers were able to observe Museum educators using a range of early-learning strategies that were steeped in science. For example, the melody for "Head, Shoulders, Knees, and Toes," a popular children's song, was the basis for a song about the parts of a butterfly. As observers, Pre-K teachers also noticed the objects, books, specimens, animals, and halls that children and families enjoyed and accessed, which gave them new ideas for their own classrooms.

Recommendation: Because teachers learn from observing the practice of others, we recommend providing opportunities for teachers to observe Museum educators facilitating early-childhood science lessons in Museum classrooms and halls. Observing Museum educators can help early-childhood educators to consider their own teaching and learn new ways to invite early learners into conversation, engage parents in children's learning, and select objects and organisms that may be interesting and useful as teaching tools in their own classrooms.

In the Initiative, Early-Childhood Educators Gained Knowledge and Skills for Building Strong Science Foundations

In this Initiative, early-childhood teachers were invited to see science phenomena in the classroom, Museum, and natural environments as they reflected on their everyday experience in the Pre-K classroom. Through SIMPL, a process of observation, questioning, and synthesizing of their experiences (akin to engaging in science practices), they were better able to describe the science learning already happening in their classrooms and to identify additional opportunities for learning science with everyday materials that were already being used. Learning in the Museum served to encourage the teachers to utilize even more of the environment around their schools (e.g. by taking children on nature walks). Schools that had science centers adopted new ways of encouraging student participation at those centers or created multiple entry points into science exploration and discovery in their classrooms. Lastly, many teachers adopted a new interdisciplinary approach to science learning, seeing science reflected in lessons that might have traditionally been framed through other disciplinary lenses, such as a math lesson or a literacy lesson. As many teachers put it, "science is everywhere!"

WHAT DOES SCIENCE LEARNING LOOK LIKE FOR YOUNG CHILDREN AND FAMILIES?

There is a robust body of literature that speaks to the merits of young children actively engaging with objects, playing, asking questions, and partnering with adults to develop new understandings (Hadani, 2013). The Museum offers a unique environment in which children gain exposure to dioramas depicting places they may never otherwise see in person or objects they may never otherwise observe in three dimensions. Providing children and families from the partner institutions with fun and educative science experiences in the Museum was essential for complementing and enhancing school science learning. Below are insights that were gained from children's and families' participation in this Initiative.

Children Explored, Learned, and Played in Science-Rich Environments

The design of the Initiative supported children's science learning at the Museum and teachers' learning in an effort to bolster science learning in schools.

Young Children's Science Learning at the Museum: Children, especially early learners, are curious about the world around them. Visits to the Museum were special experiences for them because school trips are not common for Pre-K children, especially in New York City. Children loved coming to the Museum with their classes. Even for those students who have visited before, the Museum offers something new and exciting each time they visit. Museum spaces elicit young learners' natural tendencies to wonder and describe: "I see that! That's a bear! Look, Mom!" Importantly, children were thrilled to have the chance to learn alongside their families or caregivers as they did something educational and fun together. Specific strategies used in these Museum visits included expeditions to specific destinations, such as dioramas, found in the Museum halls and a "feature creature" introduction of a live animal to complement the lesson.

When they visited, children were encouraged to touch, feel, listen, etc., rather than passively listening to or looking at the objects or environment around them. This active approach reinforced for them that museums are places to have fun, to be active, and to explore. Below is an illustration of some of the ways in which children's natural tendency towards being scientists and engaging in science practices were nurtured through the partnership.

CHILDREN EXPLORED, LEARNED, AND PLAYED IN SCIENCE-RICH ENVIRONMENTS: SENSES CLASS VISIT

In the winter of 2017, Pre-K teachers and children and families from two of our partner institutions opted to visit the museum to explore the five senses for their fall class trip. These visits were tied to a unit common to many Pre-Ks in the city, where early learners explore their five senses. As part of this visit, children and families got to visit a special exhibition on human and animal senses titled Our Senses: An Immersive Experience.

Each of the visits followed a similar format: children were invited to the classroom and participated in a "rug meeting" to explore the topic for the day; explored the special exhibit; returned to the classroom to do free exploration; engaged in a reflective discussion about what they noticed and wondered about their senses; and, finally, got to learn about a feature creature, the animal for the day.

When the Pre-K classes from the partner sites visited the Museum for their senses experience, they filed off a bus and into one of the science-rich classrooms. As they walked in, the children and parents gasped with excitement, noticing all the animals, artifacts, wall hangings, and plant life that surrounded them. They were then invited by Museum educators to join them on the classroom rug so they could participate in a discussion. During this opening discussion children shared what they knew about their own senses and got prepared to explore the Museum. For senses, Museum educators used images to catalyze a discussion. For example, they held up a picture of a nose and asked the children, "What does this do?" The children responded enthusiastically, "SMELL! SNIFF!" The educators repeated this process for each sense. At other times, Museum educators encouraged the children to turn and talk to their adult learning partners about their assumptions or questions.

Then, along with their parents, children walked through the Museum to the Senses special exhibition. There, children and their adult learning partners used prompts on a clipboard to guide them through the different rooms of the exhibition to explore sight, touch, smell, and hearing. In the room focused on the sense of sight, children watched as the walls in the room changed color, and as the colors changed, they revealed different images that were not visible in a previous hue of light. They eagerly and patiently looked around the room with their adult learning partners as the lights turned from a hue of red to blue to green and onwards, all the while searching for four animals. (See **Appendix** for worksheet). In the audio room, children and their adult learning partners plopped down on comfy couches and listened to an audio track that played a range of sounds—city buses, sirens, jazz music, the sound of a rainstorm, and more. Some teachers and students happily danced when they heard the jazz playing. When they arrived in the room focused on the sense of smell, children ran around, flipping little "smell dispensers" and wondering out loud about what the smells were, trying to connect the odor to others they have smelled before and to determine which might be part of the smell of chocolate cake. Children did what was natural to them when in the room designed for the sense of touch—they ran their hands along surfaces, scratched things, and rubbed or poked at them, working with their adult learning partners to describe what they were feeling: Squishy? Rough? Cold?

Upon returning to the Museum classroom, children spent time debriefing and making sense of what they had seen, touched, heard, and smelled in relation to what they had previously known about senses. Then they explored the Museum classroom, where additional experiences were to be had that would involve using their senses. The children also ran around the room freely peeking into the numerous animal tanks and terrariums that are housed in all the Museum classrooms. Located throughout the room were materials to support children as they explored senses: art activities, puzzles, animals ensconced in amber, and essential oils for smelling. Children pulled their parents along or linked up with friends as they moved around to different areas of the room to utilize the different learning materials.

During these visits, children were free to explore, encouraged to work with their adult partners, and had the freedom, time, and space to be learners. The multi-sensory visit was impactful because it built on learning they had done with their teachers at school and resonated with young learners, who are natural scientists and explorers, constantly eager to touch, smell, see, listen, and taste!

When Pre-K children visited the Museum, they were encouraged to embrace their curious selves and gain exposure to novel objects, animals, and environments. In the senses-themed visit, the children were able to reflect on what they were doing—seeing/hearing/smelling/touching—while doing it within the context of a science museum. They also were working in tandem with their parents to do these things, thus creating a *shared* experience that would travel back to school and to home.

Young Children's Science Learning in School: The partnership approach of this Initiative was intended to support children's science learning at school as well as at the Museum. The early-childhood teachers in this Initiative invited Museum educators to observe children's science learning in their classrooms. While explicit planning for all classroom teaching of science was not part of the Initiative's design, there was evidence from these observations and teacher self-reports that the teachers' participation in professional-learning conversations about characteristics of high quality early-childhood science learning was applied to design a variety of science learning opportunities for young children. The following example provides a window into what children's science learning looked like in one of the classrooms and a way in which the professional learning was potentially influential in the learning design.

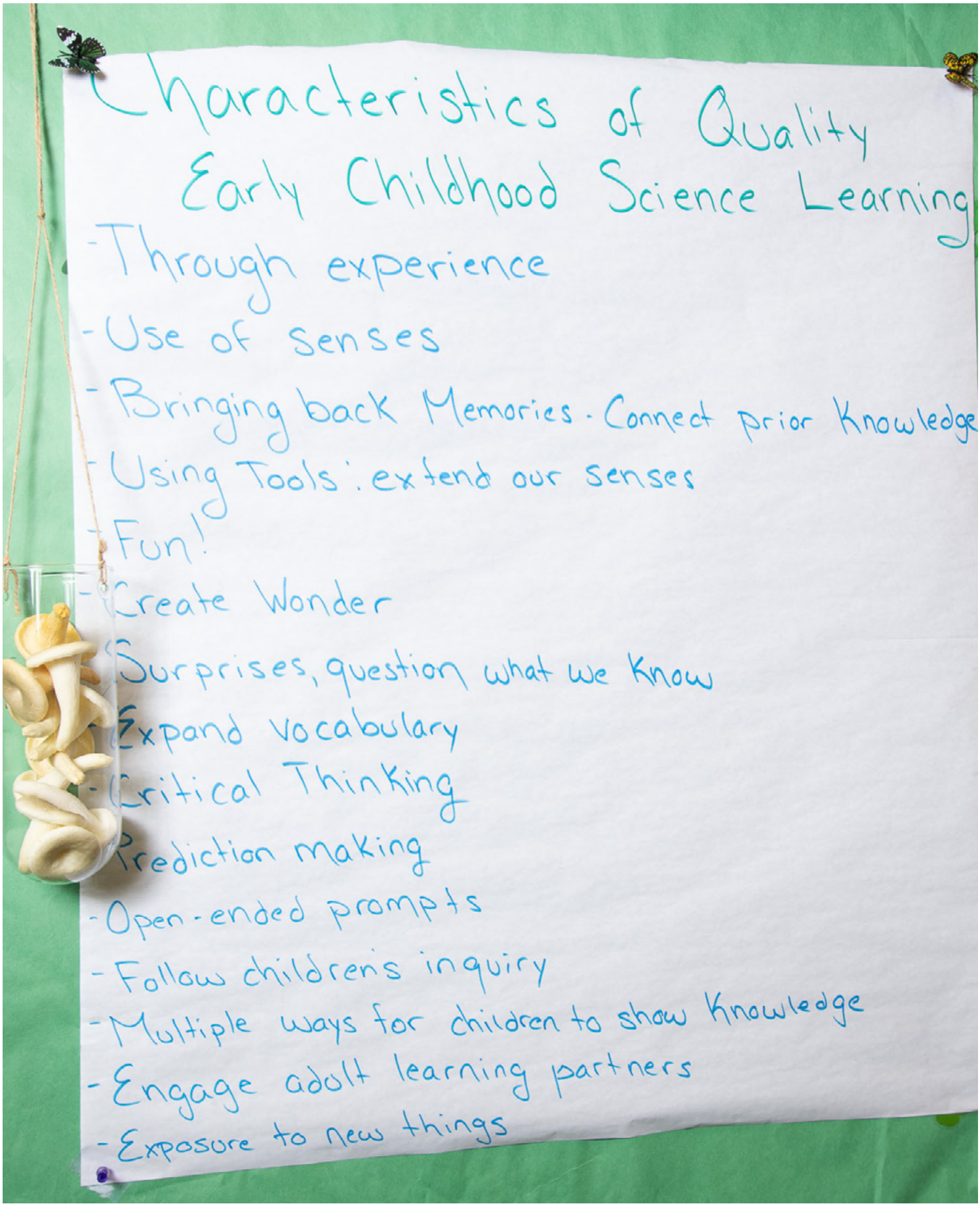
CHILDREN'S SCIENCE LEARNING IN PARTICIPATING TEACHERS' CLASSROOMS

"Light" is a topic of study in the NYCDOE Pre-K for All Interdisciplinary Units of Study the curriculum developed to be implemented in Pre-K for All classrooms, and thus is taught in the schools. Many of the "Characteristics of High-Quality Early-Childhood Science Learning" **[see image]** that were co-constructed during the professional-learning sessions of the Initiative were apparent in the design of children's science learning during an observed early-childhood lesson on "light."

One characteristic described by teachers in the professional learning was "making connections between what [early learners] were learning in school with what they experienced out of school and with their personal interests." Two of the teachers in this Initiative who shared a classroom deeply considered how to make sure that children not only learned about light, but were able to make connections between what they were learning in school with what they experienced out of school and with their personal interests. While there are several suggestions in the curriculum materials for how to integrate "light" into children's learning centers (i.e., stations that the young learners circulate to at different points in the lesson) the list below describes some ways in which teachers were intentional in supporting children in making connections:.

- The class went to observe a particular tree in each new season—fall, winter, and spring—so the teacher had the children make pipe-cleaner artwork of the tree and use that as a subject for exploring shadows with flashlights.
- The teacher had the class vote on a design for a dramatic play area, and the children selected a campsite. The play in this space consisted of children roasting marshmallows on a pretend campfire (a "natural" light) and carrying around lanterns ("artificial" light) in addition to playing during "daytime" with sunlight and "nighttime" with moonlight.
- Two of the children were eager to "write" their own story. The teacher encouraged them to do this and they each drew pictures and lined up the pages to tell their story. Throughout the story, the teacher probed for ways they discussed light in the context of the story.

Each experience the children (and their parents/families) had doing and learning science both at the Museum and in their school classrooms provided an opportunity to build a foundation for lifelong curiosity about science and nature, and later school science learning.


Characteristics of Quality
Early Childhood Science Learning
-Through experience
-Use of senses
-Bringing back Memories - Connect prior Knowledge
-Using Tools: extend our senses
-Fun!
-Create Wonder
-Surprises, question what we know
-Expand vocabulary
-Critical Thinking
-Prediction making
-Open-ended prompts
-Follow children's inquiry
-Multiple ways for children to show Knowledge
-Engage adult learning partners
-Exposure to new things

Parents Were Directly Involved in Children's Science Learning

Parents and caregivers were able to learn with and from their children as they engaged as learners during Museum experiences: Children and parents were encouraged to be curious, to explore, and to ask questions. During visits to the Museum, parents and children explored the Museum halls or special exhibitions related to the theme of the visit. Parents supported children's inquiries as well as their own by reading signs or placards that provided information about various scientific phenomena. Parents assisted young learners by reading signs or describing complex displays. Parents sat with their children to watch a film in an exhibit that they could discuss later. Parents and children pointed out to one another new ideas, organisms, and objects, and could be heard asking one another questions about what they saw, heard, and observed.

Museum educators and teachers together created multiple opportunities for parents to participate in formal and informal educational experiences with their children. These science-learning opportunities positioned parents as learners and explorers, and not just as support for their children, during visits to the Museum.

PARENTS ARE ACTIVE LEARNERS AT THE MUSEUM

Parents and children work together as learners in all the Museum visits. During a class about "animal habitats," parents and children from a class of four-year-olds sat on a rug listening to one of the Museum educators describe the nature of "animal collections." The talk built on previous conversations about how museums are made up of several collections. On this day, Museum educators discussed the Museum live animal collection and encouraged children and families to explore the classroom to see the live animals in the tanks and terrariums around them.

Around the room, there were tables set up for children to observe snails that had been placed in small magnifier cups, to examine millipedes, and to look around at the other live animals in tanks that lined the perimeter of the room, including walking sticks and turtles. To support the exploration, the Museum educators had given children "animal information cards" so they could walk around matching the card to the actual animal. Parents and children worked in tandem, peeking into the tanks and observing the animals. At times the children took the lead on looking for the animals, and at other times the parents gestured or pointed to details that the children might not have otherwise noticed. Having their parents with them meant that children were able to get support in finding the animals and had someone to talk to about their explorations. Parents were also genuinely curious about the different species.

Later on, the search for animals continued in the rainforest exhibit within the Hall of Biodiversity, where parents and children were asked to match laminated photographs of the animals hidden in the exhibit to the actual replicas within. There was a bustle of activity as children and their parents looked at the pictures together and discussed where they might find the each of the animals; many of the animals were new to both the children and parents, as the Dzanga-Sangha rainforest has many unique species.

Then, upon returning to the classroom, the children joined in a conversation about the day's "feature creature" as they were introduced to a hissing cockroach from Madagascar. They were told that the cockroach is an animal who "cleans up in the forest." The children learned the word "exoskeleton" and learned how to use two fingers to gently touch the animal. As the cockroach made its way around the circle, some of the parents also participated in touching the cockroach. Even though some of the parents admitted out of earshot that they were scared of the cockroaches, they were willing to be daring and take a risk because they wanted to encourage their children to do the same.

During this class visit, children and families engaged in a range of science practices: They observed, identified, and organized animals into different classifications. There were three parts of this Museum visit that provided opportunities for them to engage in these science practices: 1) as the children and parents examined closely the live animal collections in the museum classroom; 2) as children and parents explored the rainforest, when they questioned and hypothesized where a specific animal might live and why it might live there—for example, a child holding a picture of a bird had a discussion with his parent about where birds live or perch and how that might be different from the animals that live on the rainforest floor; 3) as the children and parents observed, touched, and asked questions about the feature creature—a hissing cockroach—which resulted in children seeing the antennae, the exoskeleton, and the moving legs as well as learning more about what the cockroach eats, where it originates from, and so on.

The Initiative took into account not only how to actively support teachers in providing high-quality science-learning experiences for young children, but also how to involve parents, caregivers, and families in the process. The learning was relevant to children and families as it related to the natural world in which they lived every day, even if some of the environments that they explored in the Museum were novel or represented places far away. This provided opportunities to facilitate children's ability to make connections between school, the outside world, and home. Adults across the children's lives were better positioned to support this kind of connection-making because parents know what the children's life experiences are and have been outside of school; teachers are aware of (and help to construct) the children's experiences in school; and these influential adults talking to their children about their experiences, or replicating their Museum experiences elsewhere, enhances the potential for learning through children making connections, developing language, and engaging in science practices (Hadani, 2013).

Recommendation: Because young children learn science through their own experiences, exposing them to science phenomena, practices, language, and concepts is essential for building a foundation for lifelong curiosity about science and nature, and later school learning. We recommend working with not only teachers, but also parents, to support them in helping young children see the science in the world around them and to enrich the opportunities for science learning that happen every day in school, at home, and in all the places a child may visit.

Conclusions and Next Steps

INCREASING ACCESS TO HIGH QUALITY EARLY-CHILDHOOD SCIENCE LEARNING

In the introduction to this report, the American Museum of Natural History put forth the idea that d**eveloping partnerships with schools and community-based organizations with Pre-K children is a successful strategy for expanding access to high-quality science for young children and their families.** Throughout this Initiative, the Museum explored two partnership models in order to develop a greater understanding of the full potential of each model. The Museum learned that the model used with the Bloomingdale Family Program, PS 84, and PS 111 allowed the Museum to reach a greater number of children. The model used with Goddard Riverside Head Start allowed the Museum an opportunity to connect directly and more intimately with a smaller number of families and, in turn, to support those families in continuing on in family programs such as the Science and Nature Program.

Some of the limitations of the work provide great opportunities to continue to explore further. For example, through careful selection of community partners, the Museum had the opportunity to further understand the potential for how this work could be expanded and tailored to teachers, children, and families from diverse socioeconomic, cultural, and linguistic backgrounds. However, this aspect of the work was not tested to determine the extent to which specific strategies such as having bilingual Museum educators affected the children's or teachers' learning outcomes. Similarly, Museum staff and researchers gave a lot of consideration to the ways in which parents participated in children's learning, yet the ways in which the Initiative may have influenced parents' perspectives of science and science learning or their capacity to do science alongside their children was not explicitly measured or assessed in the context of this work. Finally, questions remain regarding how high-quality science-learning experiences work in tandem or support early learning in general. Future work should account for these limitations and the opportunity to learn more about young children's learning of science in museums, at school, and at home.

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Appendix

150 YEARS
AMERICAN MUSEUM OF NATURAL HISTORY

Appendices

American Museum of Natural History
100kin10 Launch

Supporting Teachers' use of Active STEM Learning with PreK Students and their Families at School, Museum, and Home

Wednesday, June 7, 2017
9:15 a.m. - 11:30 a.m.
Portrait Room, 2nd Floor, American Museum of Natural History
Central Park West and 79th Street
New York, NY 10024

Meeting Agenda

9:15 - 9:30 a.m.	Arrivals/Breakfast *All*
9:30 - 9:40 a.m.	Welcome/Introductions *Ruth Cohen* *Senior Director, Education Strategic Initiatives* *Director, Center for Lifelong Learning* *American Museum of Natural History* *Jenny Ingber, PhD* *Director, Children and Family Learning and the Science and Nature Program* *American Museum of Natural History*
9:40 - 10 a.m.	Our Context for the Work *Jenny Ingber, PhD*
10:00 - 10:20 a.m.	Project Goals and Big Questions *Marina Stenos* *Senior Vice President and Director* *Widmeyer Communications* *Jacqui Lipson* *Vice President* *Widmeyer Communications*
10:20 - 11:15 a.m.	Partners' Visions of Success *Jacqui Lipson*
11:15 - 11:30 a.m.	Reflection and Next Steps *Jacqui Lipson*

Expanded Agenda

Time	Topic	How we will do it	Facilitator(s)
9:15-9:30	Get food/ settle in		
9:30-9:40	Welcome/ Introductions	Introduce self, institution's mission, and what they do with PreK. Size, length of involvement. Introduce Finn Marina/ Amy/ Jacqui	Jenny/Ruth
9:40-10:00	Context for the Work	Here are the reasons we wanted to begin work in this area...Ultimately, in our experience, we know active STEM learning in early childhood classrooms will have benefits for low-income children/families and this left us wondering the best approach(es) for using our expertise to provide learning opportunities for this audience. In what ways are you working with children and families? How do you perceive this work would fit with what you are doing/would like to be doing? How can the Museum/Science amplify the learning and sense of community at your school/center?	Jenny
10:00-10:20	Goals of the Project and Big Questions	Share what is on the slide… Put each Question on a Large poster in the room. Pass out small post-its to get partners initial ideas about each of the questions. How can they help us to achieve the larger goals?	Jacqui
10:20-11:15	Partners' Visions of Success	How can we facilitate this to answer some of the following? I set aside a lot of time for this… want it to productively build excitement about potential and also surface constraints... ● In what ways do they currently work with young children and families? ○ How do families engage with content at home? At the Museum? What the mechanisms to discover and share these	Jacqui

		efforts? ○ **What are the barriers to making this happen?** ● **How does this project align with their current work?** ● **What resources do they have/need for supporting early active STEM in their schools/classrooms?** ● **How frequently are administrators and teachers to participate in meetings/PD?** ○ **How and when do parents/caregivers interact with teachers?** ● **We would like to find a way to build community within and across partner sites. What recommendations/ideas do you have for this?** ● **What are the opportunities to partner? What are the barriers to partner?**	
11:15-11:30	**Reflection and Next Steps**		

1. 10 min for food and gathering
2. Introductions - (Jenny/Ruth) Acknowledge everyone at the table and some basic contributions to the project. Introduce Finn Marina/Amy/Jacqui (10 min)
3. Jenny - we have identified areas that we at museum think are the Context for work - but would like to hear from everyone their context...posters with our ideas invite others to add (15min)
    a. impact of EC learning - low income families greatly benefit from structured learning environments, research on 0-5 literacy/reading to children and math as indicator of later school success.
    b. NYC responsiveness to these understandings - UPK for all 3PK
    c. AMNH vision of the value of science in EC (in this environment rewarding to families and kids).
    d. Needs constraints strengths
4. Present in a framework for project and outlines goals
    a. Project Goal Statement: _ To improve PreK teachers use of active science learning with preK students by bridging learning experiences across school, Museum and home.
    b. 3 areas we are investigating and some questions we have around these areas...

Partnership Objectives:

- AMNH Recruits partners who offer preK learning from NYCDOE and from local CBOs
- AMNH co-creates PD and class visit implementation plan with each site (and/or sites together)

NOTE: throughout this process we want to understand what is feasible for each partner--we are going in with the understanding that each has their own regulations, curricular expectations, needs, leadership, and constituents. The work across all sites will be ground in the same theoretical framework, will use the same practices, and will have the same goals in mind, but the science content integrated into the learning and the contact hours with teachers and/or children may vary.

PD Objectives:

- PreK teachers engage in authentic and active science learning for their own content development;
- PreK teachers use strategies for engaging adult learning partners (e.g. parents) in their children's science learning;
- PreK teachers design active science learning experiences for children at school and at the Museum;
- PreK teachers reflect on their science teaching and learning to inform their planning and enacting of learning experiences at school and at the Museum

NOTE: the work across all sites will be grounded on the same theoretical framework, will use the same practices, and will have the same goals in mind, but the science content integrated into the learning and the contact hours with teachers and/or children and families may vary in order to be able to integrate more naturally into the teachers' everyday practice and the regulations/needs of specific partners/school communities.

Research objectives:

- Researchers identify the degree to which different features of the professional development model seem to contribute to teachers' use of specific STEM teaching strategies for PreK classrooms.
- Explore and describe the Community resources and challenges associated with developing and establishing partnerships in three very different PreK learning sites, and identify strategies that build upon the assets as well as help address any challenges.
- Surface indicators of positive outcomes for students, teachers and families.

5. Articulate different partners and what they currently bring - their goals and their contributions - inputs.. timeline and meetings (logic model)
    a. Needs constraints strengths
6. Closure and next steps.

Supporting Teachers' use of Active STEM Learning with PreK Students and their Families at School, Museum, and Home

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AMERICAN MUSEUM of NATURAL HISTORY

THE SCIENCE AND NATURE PROGRAM

Memorandum of Understanding

The American Museum of Natural History supports science learning for young children by establishing partnerships with schools and community organizations which engage school leaders, early childhood teachers, children and families in science learning that integrates Museum resources. Through these Museum-School partnerships, AMNH strives to promote early childhood science learning and lifelong learning, and to establish a welcoming culture for all at the Museum.

This Memorandum of Understanding (MOU) will broadly outline the partnership structure between AMNH and P.S. 084 Lillian Weber School of the Arts for the year beginning August 1, 2017 and ending July 31, 2018. Both parties acknowledge that the structure outlined below is aligned with compliance and deliverables for the 100kin10 grant awarded to the Museum.

Scope

This partnership has the following goals:

1. Support P.S. 084 Lillian Weber School of the Arts prekindergarten teachers' instructional practices involving inquiry-based learning and teaching in science;
2. Create engagement opportunities at the Museum throughout the year for children, families and P.S. 084 Lillian Weber School of the Arts community;
3. Document, evaluate and research the outcomes of the partnership for inclusion in the larger report to 100kin10, research publications, and in our respective communications.

In order to accomplish these goals, the AMNH will implement a year long Museum-based professional development program with teachers at the P.S. 084 Lillian Weber School of the Arts that emphasizes early childhood learning and teaching strategies, builds teachers' science content knowledge, fosters the integration of Museum resources and science learning experiences into teachers' curriculum, and engages families in science co-learning.

The year-long partnership will consist of two professional development "cycles" that each focus on an age appropriate science concept (e.g. senses, seasons, etc.) and include professional learning experiences at the AMNH and at the school sites, facilitated and/or co-facilitated learning experience for children at the Museum, and reflective feedback sessions. Additionally, we will have events to directly engage parents and families from P.S. 084 Lillian Weber School of the Arts in science learning and also meetings to brief and get feedback from P.S. 084 Lillian Weber School of the Arts parent coordinator and administrators. The attached calendar reflects dates for all of these sessions.

In Spring 2018, at the culmination of the year, representatives from AMNH and P.S. 084 Lillian Weber School of the Arts will engage in collaborative reflection and create a plan for next steps/modifications for the following academic year.

Agreement

AMNH will provide:

Professional Learning

- 20 hours of professional learning in the forms of content and pedagogy workshops, and evaluation and reflection meetings
- 2 hours of school visits to the AMNH, per prekindergarten class - Dates TBD
- Program design in future cycles that is responsive to educators' needs and feedback

Communication with Administrators

- Presentations at fall parent orientation to support parents and families of participating classes
- Bi-weekly communication between BP.S. 084 Lillian Weber School of the Arts administrator and AMNH staff via email or phone
- Quarterly meetings with administrators
- Ongoing input into research and evaluation data interpretation and findings as well as sharing of final research and communications reports

Resources for Families, Teachers, and Classes

- Tickets which will grant access into the Museum and special exhibits (distributed to teachers at the beginning of each PD cycle)
- Instructional materials to support professional learning sessions, including teaching strategies that incorporate Museum resources
- Opportunities for P.S. 084 Lillian Weber School of the Arts teachers to observe early childhood science classes at the AMNH
- Materials for class visits (e.g., safari vests, flashlights, when available)
- Invitations for teachers and families to select AMNH special events, including weekend "Family Fun Days," etc.
- Transportation to and from the Museum on buses with car seats, as necessary.
- Food at events and professional development sessions.
- A $3000 stipend to be given to the P.S. 084 Lillian Weber School of the Arts that can be used to support this project at the organization's discretion.

For each PD Cycle, P.S. 084 Lillian Weber School of the Arts will commit to the following:

Administrators

- Ensure teacher attendance at AMNH professional learning sessions and class participation in field trips to the AMNH by arranging for teacher coverages and providing organizational support as needed
- Grant access to classroom spaces for teacher workshops, classroom visits, and research and evaluation efforts
- Bi-weekly communication between P.S. 084 Lillian Weber School of the Arts administrator and AMNH staff via email or phone
- Attend quarterly administrator meetings to provide feedback and contribute to the design of professional learning experiences for teachers
- Encourage and/or recruit parents to participate in orientations, class trips, family fun days, and research, evaluation, and communication.

Teachers

- Attend 20 hours of professional learning over the school year
- Organize and execute two class field trips to AMNH

- Communicate monthly with SNP staff via email, phone, or in-person meetings
- Provide learning opportunities for students during the school day to embed the Museum curriculum
- Offer education for parents and families affiliated with the partner classes to reinforce the value of early education and to recognize long-term educational possibilities
- Participate in research and evaluation efforts upon request by sharing classroom practices and student work

Research, Evaluation, and Communication

- Administrators, teachers, students, and families may be asked to participate in research and evaluation. Research and evaluation activities may include classroom observations, interviews with administrators, teachers, students, and families and the collection of artifacts, including samples of student and teacher work
- Administrators and teachers will assist in recruiting children and parents to participate in the research and evaluation of the project. Additionally, they will help in securing proper releases and informed consent forms from those who chose to participate.

I agree to the terms of this Memorandum of Understanding:

P.S. 084 Lillian Weber School of the Arts:	American Museum of Natural History:
_____	_____
Evelyn Lolis, Ed.D. Principal	Jenny Ingber, Ph.D. Director of Children and Family Learning
_____	_____
Date	Date

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Tel: 212-663-4070
www.bloomingdalefamilyprogram.org ▪ info@bloomingdalefamilyprogram.org

Collaboration/Partnership Agreement

Agency/Community Partner			
Address		City	State	Zip Code
Telephone #	Fax#	E-Mail	Website

The Bloomingdale Family Program invites you to work with us to serve our community. We hope this partnership establishes a relationship that fosters and enriches the services and educational experiences for our community partners as well as our early childhood program. This agreement will remain in effect until either party wishes to dissolve this collaboration/partnership. A request for a release from this agreement shall be submitted in writing to the organization.

Please complete the following statements in regards to our partnership.

The "Agency/Community Partner" will provide the following:

The Bloomingdale Family Program will provide the following:

This Collaboration/Partnership Agreement will be effective for two years beginning **January 1, 2018** and ending **January 1, 2020**.

Print Name	Print Name
Signature	Signature
Title	Title
Date	Date
Name of Agency	Bloomingdale Family Program, Inc Name of Agency

Since 1960 more than 50 YEARS serving the community

Updated: February 2016

The Bloomingdale Family Program

Our School Calendar

September 2017 - August 2018

September 2017

School Begins	September 5-11	Phase-in
In-Service Day for Staff	September 22	No School for Children
Orientation at 3:00 p.m.	September 28	171 West 107th St.
Orientation at 3:00 p.m.	September 29	125 West 109th St. 987 Columbus Ave.

October 2017

Columbus Day	October 9	No School for Children In-Service Day for Staff

November 2017

Election Day	November 7	No School for Children *Mini–Parent/ Teacher Conferences**
Veterans Day	November 10	No School for Children *Mini– Parent/ Teacher Conferences**
Thanksgiving Day	November 23 & 24	School Closed

December 2017

In-Service Day for Staff	December 6	No School for Children
Christmas	December 25 & 26	School Closed

January 2018

New Year's Day	January 1-2	School Closed
	January 3	School Reopens
In-Service Day for Staff	January 12	No School for Children
Martin L. King Jr.'s Birthday	January 15	School Closed
Parent/Teacher Conferences*	January 29 - 30	No School for Children *At 987 Columbus Avenue*
Parent/Teacher Conferences*	January 31	No School for Children *At 125 W 109 St. and 171 W 107th St.*

February 2018

Parent/Teacher Conferences*	February 1	No School for Children *125 W 109th St. and 171 W 107th St.*
In-Service Day for Staff	February 12	No School for Children
Presidents Day	February 19	School Closed

March 2018

Good Friday	March 30	No School for Children In-Service Day for Staff

April 2018

In-Service Day for Staff	April 16	No School for Children

May 2018

In-Service Day for Staff	May 7	No School for Children *Home Visits*
Alumni Reunion	May 7	No School for Children
Cultural Diversity Days	May 17 & 18	
Memorial Day	May 28	School Closed

June 2018

Picture Day	June 1	
Parent/Teacher Conferences*	June 11 - 12	No School for Children *At 987 Columbus Avenue*
Parent/Teacher Conferences*	June 13 - 14	No School for Children *At 125 W 109th St. and 171 W 107th St.*
In-Service Day for staff	June 29	No School for Children

July 2018

Summer Program

Independence Day	July 4	School Closed
In-Service Day for Staff	July 16	No School for Children
	July 27	Graduation Day

August 2018

	August 24	End of Summer Program

This calendar is subject to change.

*Parent/Teacher Conferences Schedule

987 Columbus Avenue Site
Tuesday, November 7
Friday, November 10
Monday, January 29 - Tuesday, January 30
Monday, June 11 - Tuesday, June 12

125 West 109th Street Site
Tuesday, November 7
Friday, November 10
Wednesday, January 31 - Thursday, February 1
Wednesday, June 13 - Thursday, June 14

171 West 107th Street Site
Tuesday, November 7
Friday, November 10
Wednesday, January 31 - Thursday, February 1
Wednesday, June 13 - Thursday, June 14

School Calendar 2017–2018

Sept 7	**First Day of School** Early dismissal for non-District 75 kindergarten students only. Partial school time for pre-kindergarten public school students.
Sept 8	First Full Day for Non-District 75 Kindergarten Students Partial school time for pre-kindergarten public school students.
Sept 13	Elementary School: Parent-Teacher Conferences*
Sept 21–22	Rosh Hashanah (schools closed)
Sept 26	Middle School: Parent-Teacher Conferences*
Sept 28	High School: Parent-Teacher Conferences*
Oct 9	Columbus Day Observed (schools closed)
Nov 7	Election Day Students do not attend school. Chancellor's Conference Day for Staff Development.
Nov 9–10	High School: Parent-Teacher Conferences*
Nov 13–14	District 75 School Programs: Parent-Teacher Conferences*
Nov 15–16	Elementary School: Parent-Teacher Conferences*
Nov 23–24	Thanksgiving Recess (schools closed)
Nov 29–30	Middle School: Parent-Teacher Conferences*
Dec 25–Jan 1	Winter Recess (schools closed)
Jan 15	Dr. Martin Luther King Jr. Day (schools closed)
Jan 26	Regent Scoring Day High School students do not attend school, except those enrolled at D75 school programs.
Jan 29	Chancellor's Conference Day for High Schools High School students do not attend school, except those enrolled at D75 school programs.
Jan 30	Spring Term Begins for High School Students
Feb 16–23	Lunar New Year and Midwinter Recess (schools closed)
Mar 6–7	Middle School: Parent-Teacher Conferences*
Mar 8–9	High School: Parent-Teacher Conferences*
Mar 12–13	District 75 School Programs: Parent-Teacher Conferences*
Mar 14–15	Elementary School: Parent-Teacher Conferences*
Mar 30–Apr 6	Spring Recess (schools closed)
May 3	High School: Parent-Teacher Conferences*
May 9	Middle School: Parent-Teacher Conferences*
May 23	Elementary School: Parent-Teacher Conferences*
May 28	Memorial Day (schools closed)
Jun 7	Anniversary Day Students do not attend school. Chancellor's Conference Day for Staff Development.
Jun 11	June Clerical Day Elementary school, middle school, and D75 students do not attend school.
Jun 15	Eid al-Fitr (schools closed)
Jun 22	Regents Rating Day High School students do not attend school, except those enrolled at D75 school programs.
Jun 26	**Last Day For All Students** Early Dismissal.

NYC Department of Education
Chancellor Carmen Fariña

*Parent-teacher conference dates are citywide however, some schools may hold their conferences on alternative dates. Most schools will hold an evening conference for families in September and May. Please check with your school for specific schedules. For assessment dates and other calendars, please visit **schools.nyc.gov/calendar**.

Goddard Riverside 2017-2018 Head Start Program Calendar

4 Independence Day
28 Professional Development

JULY 2017						
S	M	T	W	TH	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

AUGUST 2017						
S	M	T	W	TH	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

31 Professional Development

1 Professional Development
4 Labor Day

SEPTEMBER 2017						
S	M	T	W	TH	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

OCTOBER 2017						
S	M	T	W	TH	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

9 Columbus Day
27 Professional Development

17 Professional Development
22 Early Dismissal
23 Thanksgiving Day
24 Black Friday

NOVEMBER 2017						
S	M	T	W	TH	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

DECEMBER 2017						
S	M	T	W	TH	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

22 Early Dismissal
25 Christmas
29 Professional Development

1 New Years Day
15 MLK Day
26 Professional Development

JANUARY 2018						
S	M	T	W	TH	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

FEBRUARY 2018						
S	M	T	W	TH	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27				

19 President's Day
23 Professional Development

23 Professional Development
30 Good Friday

MARCH 2018						
S	M	T	W	TH	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

APRIL 2018						
S	M	T	W	TH	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

27 Professional Development

Goddard Riverside 2017-2018 Head Start Program Calendar (cont'd)

25 **Professional Development**
28 **Memorial Day**

MAY 2018						
S	M	T	W	TH	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

JUNE 2018						
S	M	T	W	TH	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

22 **Professional Development**

Bloomingdale Professional Learning Sessions Plan

Cycle 1 Fall Focus: Senses
PD Objectives:

1. PreK teachers engage in authentic and active science learning for their own content development;
2. PreK teachers strategize methods for engaging adult learning partners (parents, caregivers) in their students' learning
3. PreK teachers design active science learning experiences for children at school and at the Museum;
4. PreK teachers reflect on their science teaching and learning to inform their planning and enacting of learning experiences at school and at the Museum

Worksession #1 (August 31): Bloomingdale (~22 teachers)

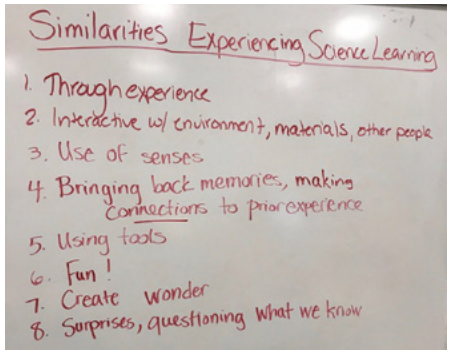
Time	Materials	Activity	Rationale/Objective Alignment/PCK element
9:00-9:15	• Breakfast • Name tags • Camera and tripod • Release forms for teachers • Table cards with prompts • Sign-in sheet	Powerpoint Arrival, Breakfast and Coffee *ENGAGE...* *On standing conversation cards on the table:* Learner: What senses are you using while you enjoy your breakfast? *Popcorn share out:* What senses did you discuss at your tables? Why do you think your senses are important?	*Objective #1:* Teachers will begin to think about senses in the context of eating their breakfast. It is assumed that they will have some prior experience with at least the 5 senses typically discussed with young children. Conceptually, this is tied to understanding the nervous system and why humans and other animals have senses (adaptation). *PCK Elements:* Community building and science subject matter knowledge
9:15-9:20	• Agenda	Set up vision for day and a little bit of the year (will visit details at the end of the day). Introduce the "Learner/Teacher" Poster.	

9:20-9:50	• Packing popcorn • Ziploc bags • Skittles • Napkins or small paper bowls • Jambox • Computer • Tape • Card at each station with directions • Guiding sheet for recording notes	*EXPLORE…* **Carousel Activity (5 min per station/1 min rotate, divide into 4 groups and rotate through stations):** *Station #1*: 1. Feel the packing popcorn outside of the bag 2. Feel the bag containing the packing popcorn. *Station #2*: 1. Close your eyes and take a skittle. 2. With your other hand close your nose (keep your eyes closed!). 3. Put the skittle in your mouth with your nose closed (it is okay to open your eyes once the skittle is in your mouth). 4. What flavor is the skittle? 5. Take your hand off your nose – what flavor is the skittle? *Station #3* 1. Stand directly in front of the jambox (align your nose with the label in the middle of the box). 2. Play the song at http://www.youtube.com/watch?v=lgpn4wBlFzo 3. Identify where the sound is coming from. 4. Stand off to the side of the jambox 5. Play the song at http://www.youtube.com/watch?v=lgpn	*Objective #1:* Without discussing senses beyond what teachers shared from the previous experience, teachers should "experience" their senses through the different station activities. They may be surprised that equilibrioception (balance) is a sense. They may be surprised that their nose is required to taste the skittles. • They should be *starting* to question their understanding of senses and also begin to relate senses to both observations and experiences and *might address* the ideas that animals have adapted senses for some evolutionary benefit. • They may also *start* to talk about senses as *tools* for observing and gathering data for answering scientific questions. *PCK Elements:* Strategies, science subject matter knowledge

		4wBlFzo 6. Identify where the sound is coming from. *Station #4* 1. Find the straight tape line on the floor. 2. Walk along the line normally. 3. Walk along the line only on your **heels.** 4. Walk along the line only on your **toes.** **Carousel Debrief (6 min)** ● Did you experience any surprises at any of the stations? ● What did all of the stations have in common? ○ Get at the idea that all required use of senses. How might they define "sense" at this point? What are some benefits for animals to have senses?	
9:50-10:45	● Safari sheet ● Clipboards ● Pencils ● TV monitor, computer and connector	*EXPLORE MORE…* **Safari (**Discovery Room 9:50-10:25**)** ● Walk down to the DR and direct teachers to play with, experience, or observe whatever they want in the space. Have them track what they do and document the senses that they used to do it. Can be done independently, in pairs, or small groups. **Safari Debrief (**Back in Classroom**)- connect to prior activity**	*Objective #1:* This is an extension of the previous activity, but one that is more open-ended. Teachers should continue to build the understanding of senses and how they are used in everyday experiences, but also consider how additional tools can help to magnify or amplify experience or observations and consider how the absence of a sense creates a different experience. *PCK Element: Strategies, science subject matter knowledge, resources*

		• What senses did they use in the Discovery Room? What were they able to observe using those senses? How might they have experienced the Discovery Room differently if they did not have one of their senses (e.g. if they were deaf or blind)? Did they use any other science tools to amplify their senses (e.g. microscopes, magnifiers, speaker volume)? **Show video clip…** **https://www.weforum.org/agenda/2017/01/humans-have-more-than-5-senses/** • Did we miss anything? • Teacher: What has learning about senses looked like for you and in your classroom for your students?	
10:45-10:50		*BATHROOM BREAK*	
10:50-11:15	• Post-it poster paper • Markers • PowerPoint • post -it notes	*EXPLAIN…* **Small Group Brainstorm (**Groups of 3-4, separate by age bands**)** Reflect on Last Year and Today's Learning Experience (discuss Science/STEM)- • What has Science/STEM learning looked like for you and your colleagues in your experiences today • What has Science/STEM learning looked like for you and your colleagues during other museum science learning experiences with us?	*Objective #4:* Most teachers from both Goddard and Bloomingdale have been working with AMNH for a year or more. This work has included science/STEM learning they experienced for themselves in PD at the Museum and also science STEM learning opportunities that they have created or co-created for their students at the Museum and/or in their classrooms. While some reflecting occurred over the course of last year, this is a chance to think holistically about how learning looks and how they construct understanding through the experiences they

		• What has Science/STEM learning looked like here and your classroom for your students? **Silent Gallery Walk** • Put posters up on the wall • Instructions: silent but come up with list of things to think about (What do you notice they have in common? What are some things that would characterize more broadly?) • Use thumbs up, smilies and question marks	have/provide rather than by "delivering content." Essentially, we want to support a sociocultural/constructivist approach to science learning for both adults and children. *PCK Element: Strategies, Resources (potentially others depending on what comes up)*
11:15-11:30	• White board • Expo markers	*ELABORATE…* **Co-Construct Draft "Principles" of STEM learning (**to be refined throughout our work together over this year and beyond!**)** • What are key principles (or elements) that would describe science/STEM learning. Bloomingdale list:	*Objective #3:* While teachers aren't designing specific learning experiences for students, they are co-defining the foundational principles they believe should be characteristic of STEM/science learning. This is a "living document" that will be refined over the course of the year with the group as they experience science learning and create learning opportunities for their own students. *Objective #4:* In order to create this list, it is essential that teachers are reflective of their own experiences with science/STEM learning. *PCK Element: Strategies, Resources (potentially others depending on what comes up)*

			
11:30-12:00	• Calendars • Planning tools? • Reflection form	**Planning for the Year** Pass out calendars, firm up dates, discuss topics to address, talk about PD plans - both at school and at Museum (observations and work sessions), discuss field trip component, talk about research and evaluation and Widmeyer, talk about family events Reflection Forms from Bloomingdale Scanned Reflection Forms Summary Data	

Characteristics of E.C. Sci. Learning

- children are interested, science area will be attractive to them
- things they can touch
- time to "play around wih stuff" & explore, with additional structure/information
- fun, not boring
- making connections to what children are interested in
- Inquiry – knowing how to ask questions and look for the answers together
- kids have/take ownership over their learning
- different modes of learning, ways of showing their understanding
- connections to nature, experiences that "stick with them" as they grow up
- "full-body" experiences, using the senses

AMERICAN MUSEUM OF NATURAL HISTORY

Building Connections Between Home School and the Museum

Focus: Change and Growth All Around Me - Plants

School	Museum	Home

ROP™
Reflecting on Practice

Observation Instrument

Focus: Making Connections

Notice. What do you see and hear happening?	**Think.** What do you think is going on? What can be inferred, assumed, speculated about, or reasoned from the observed actions?	**Wonder.** What does that make you wonder? What suggestions and implications for teaching can be derived based on observations and inferences?

Reflection Questions

1. What was something you learned today?

2. In what ways did our time together impact your beliefs about science teaching and learning?

3. What about today's session was most helpful?

4. What would you have changed/improved about today's session?

5. What else would you like to tell us about your experience with us today?

AMERICAN MUSEUM OF NATURAL HISTORY

An Evening with the Dinos Family Fun Night

The

_____

Family's Exploration Passport

Family Fun Night:
AMERICAN MUSEUM OF NATURAL HISTORY

Welcome to the Family Fun Night at the American Museum of Natural History!

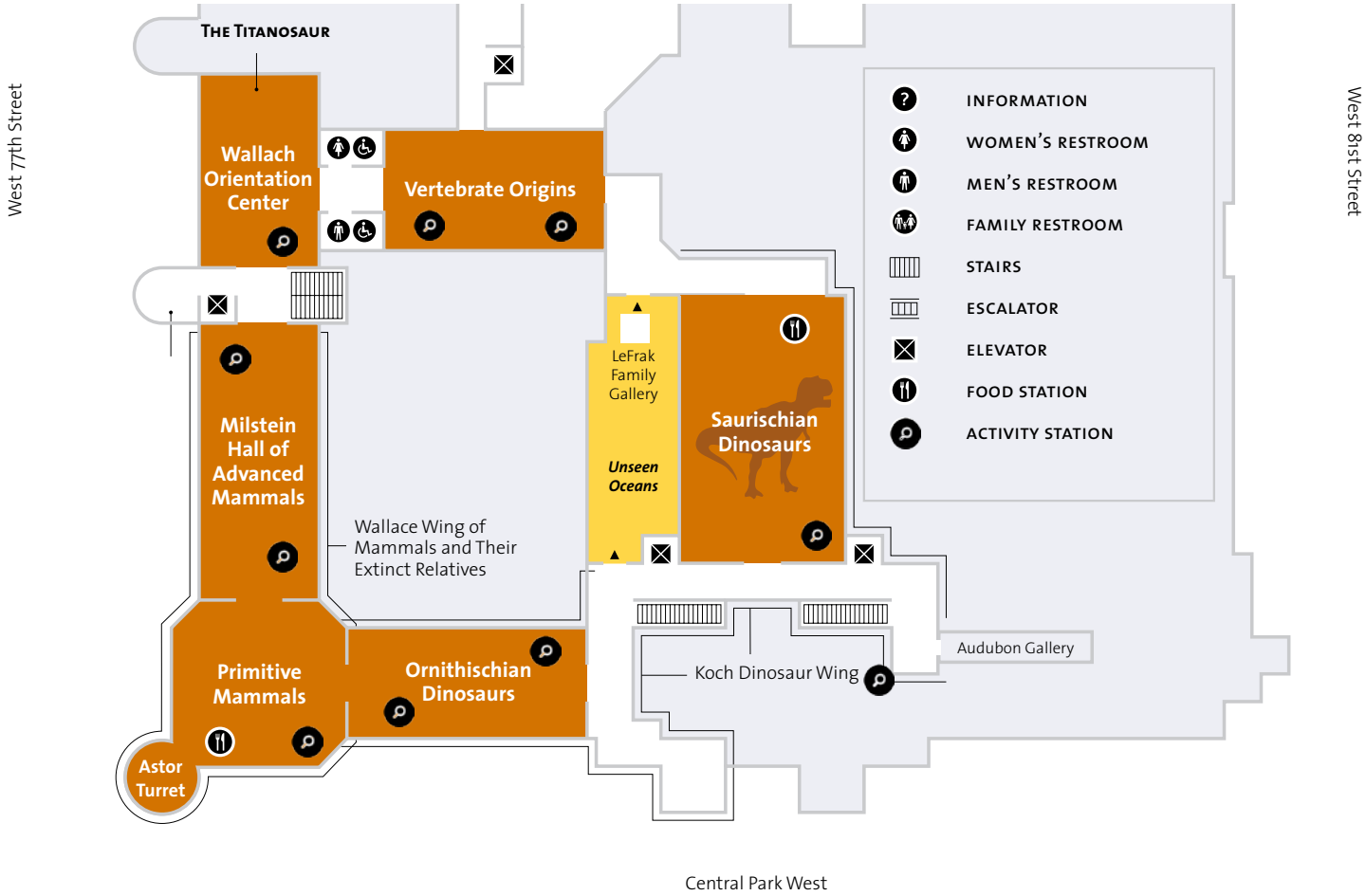
Tonight, your family will explore the fossil halls and encounter several activity tables. Adults, please read the prompts from this Passport to the children, write down their answers, and talk to them about what they see to help them complete the activity. **WHEN YOU FINISH** all of the activities, stop by the check-in table to pick up a **PRIZE**!

The locations of food stations, bathrooms, and the activity tables are highlighted on the map below.

Have an amazing adventure!

Museum Map

FOURTH FLOOR



The Terrific Titanosaur:
WALLACH ORIENTATION CENTER

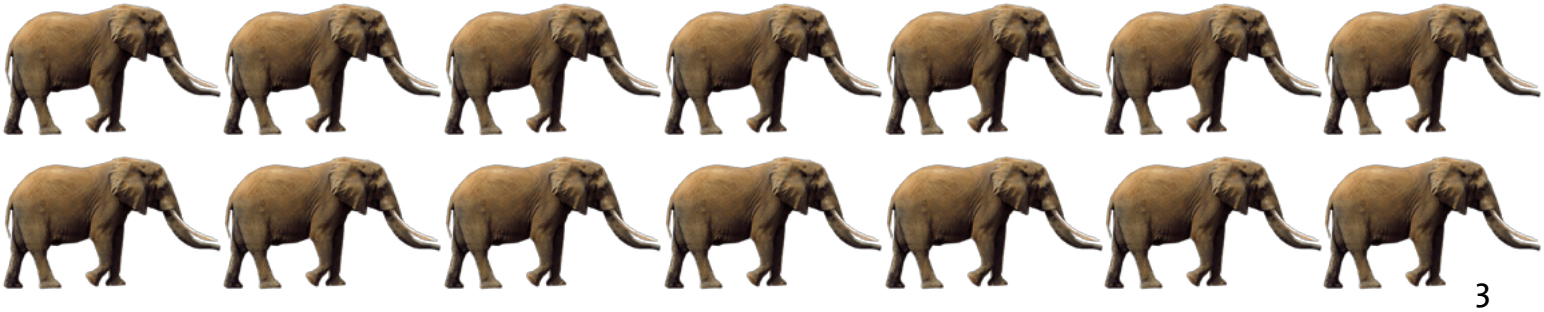
The Titanosaur is the largest dinosaur on display in the whole world. **MEASURE** its length by counting the number of steps it takes you to **WALK** from the start of the snout to the tip of the tail.

How many steps did you take from the dinosaur's head to the base of its neck?	How many steps did you take from the base of the neck to the end of its bottom?	How many steps did you take from the end of its bottom to the tip of its tail?
_____	_____	_____

ADD all of your steps: _____

Measuring 122 feet in length, the Titanosaur is probably the largest animal ever to have walked the Earth. That's as long as how many city buses? _____

And as heavy as how many elephants? _____

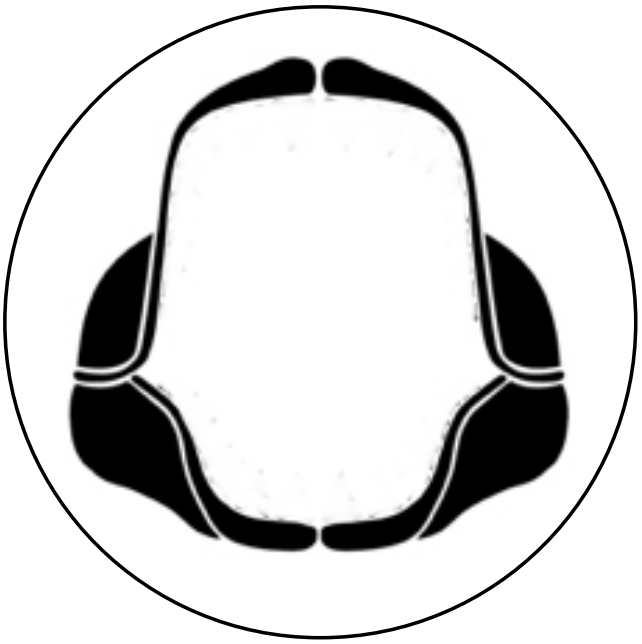


3

Sink Your Teeth Into Sharks:
HALL OF VERTEBRATE ORIGINS

LOOK UP. The jaws of the largest known shark hang above you. *Carcharodon megalodon*'s jumbo jaws give us a sense of the size of the entire animal. Imagine how big the rest of this ancient predator was!

ADD the missing teeth to the jaw below.



What **SHAPE** are the teeth? _____

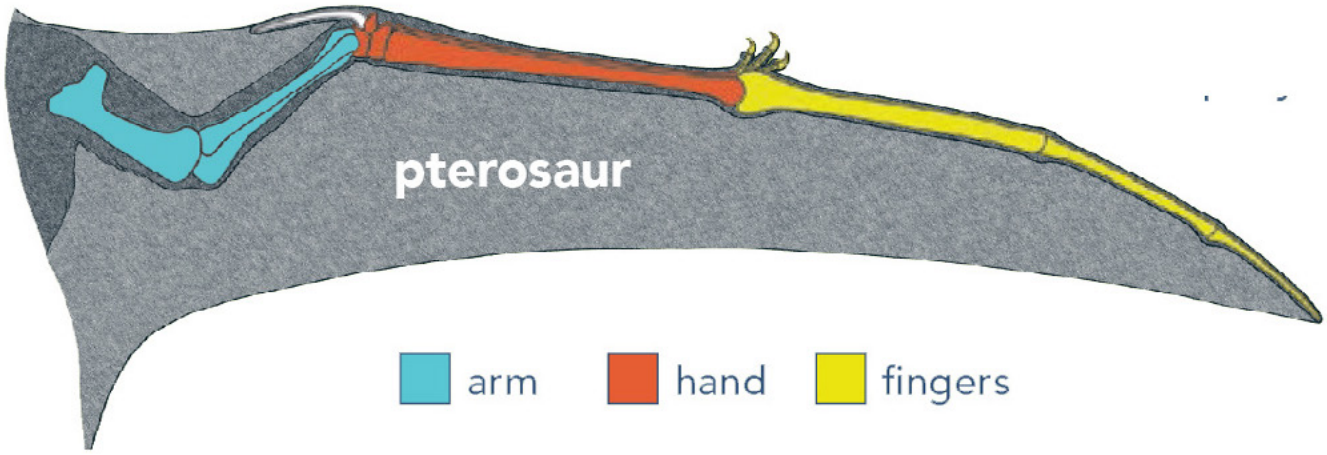
DRAW one tooth.

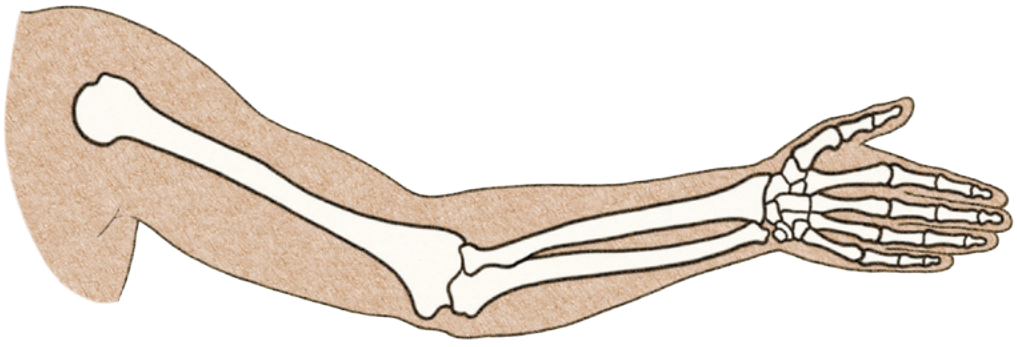
Pterosaurs on the Wing:
HALL OF VERTEBRATE ORIGINS

SPOT the similarity. The bones in the wings of the pterosaur correspond to the bones in the wings of bats and birds, as well as to those of the human arm.

LOOK at the pterosaur wing and **COLOR** in the matching bones in the human's upper limb. Use the same color for each corresponding part.

Were you surprised by which bones match?





human arm

Tale of the Trackway:
HALL OF SAURISCHIAN DINOSAURS

The footprints below the *Apatosaurus* are a perfect example of a **TRACE FOSSIL**: no bones are preserved, but evidence of these animals remains. This trackway was collected from the Paluxy River in Texas in 1938.

LOOK carefully. How many kinds of footprints do you see? **DRAW** or **RECORD** them below:

TELL the story of what might have happened here in **WORDS** or **PICTURES**.

Safe in an Eggshell:
HALL OF ORNITHISCHIAN DINOSAURS

Baby dinosaurs hatched from **EGGS.** We know this from finding fossilized eggs in the ground. Sometimes, they are even arranged in **NESTS**.

Can you **FIND** fossilized eggs and nests here in the hall? **CHECK** them off and **COUNT** the eggs.

☐ _____ eggs

☐ _____ eggs

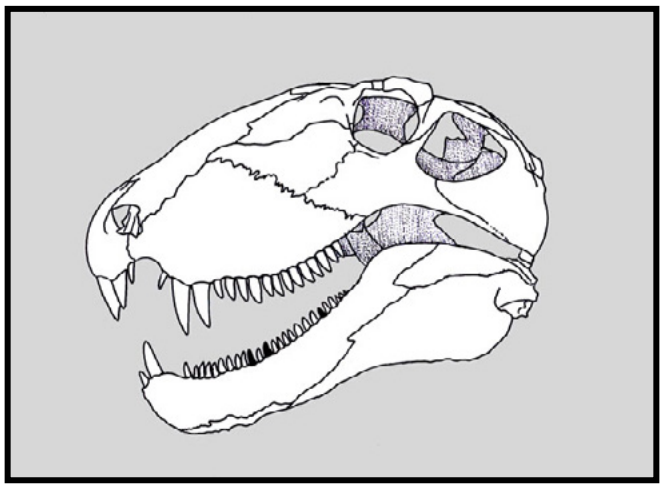
☐ _____ eggs

DRAW eggs in the box to the right. What **SHAPE** are they?

Do You Know *Dimetrodon*?

TOUCH the specimens on the table.

Where would *Dimetrodon*'s eye be? **CIRCLE** the spot.



Dimetrodon is known for the giant sail on its back. **FIND** the specimen in the hall. Does it match the illustration? **DRAW** the missing parts on the skeleton below.

Terrific Teeth

Mammoths, mastodons, and modern-day elephants all possess massive teeth that are well adapted for their particular diets. Mammoths (like elephants) lived in wide open grasslands, with lots of grasses to eat. Paleontologists think that mastodons made their homes in the forests of North America.

TOUCH the teeth.

RIP the **LETTUCE** and the **LEMONGRASS**.

Which is easier to tear? _____

GRIND the **LETTUCE** and the **LEMONGRASS**.

Which material is tougher to grind? _____

Tip-Top Toes

FIND the "Evolution of Horses" display. **LOOK** at all of the ancestors on the horse family tree. Modern horses walk on hooves. Each foot or hoof is made up of a single toe! Do the feet of all of their ancestors look the same? How many toes did they have on each foot?

How many toes do you have on one foot? **TRACE** your foot and **COUNT** your toes.

Family Fun Night:
AMERICAN MUSEUM OF NATURAL HISTORY

Thank you for coming! We hope you've enjoyed your visit.

Did you enjoy the dinosaurs, but wish you'd gotten a taste of animals that still live on Earth today? Ask your teacher for tickets to return to the Museum to explore more of our displays. While you're here, take in our newest exhibition, *Unseen Oceans*. It celebrates the richness of the ocean and our attempts to learn more about our planet's largest habitat.

UNSEEN OCEANS

Open daily 10:00 am - 5:45 pm, except on Thanksgiving and Christmas Day

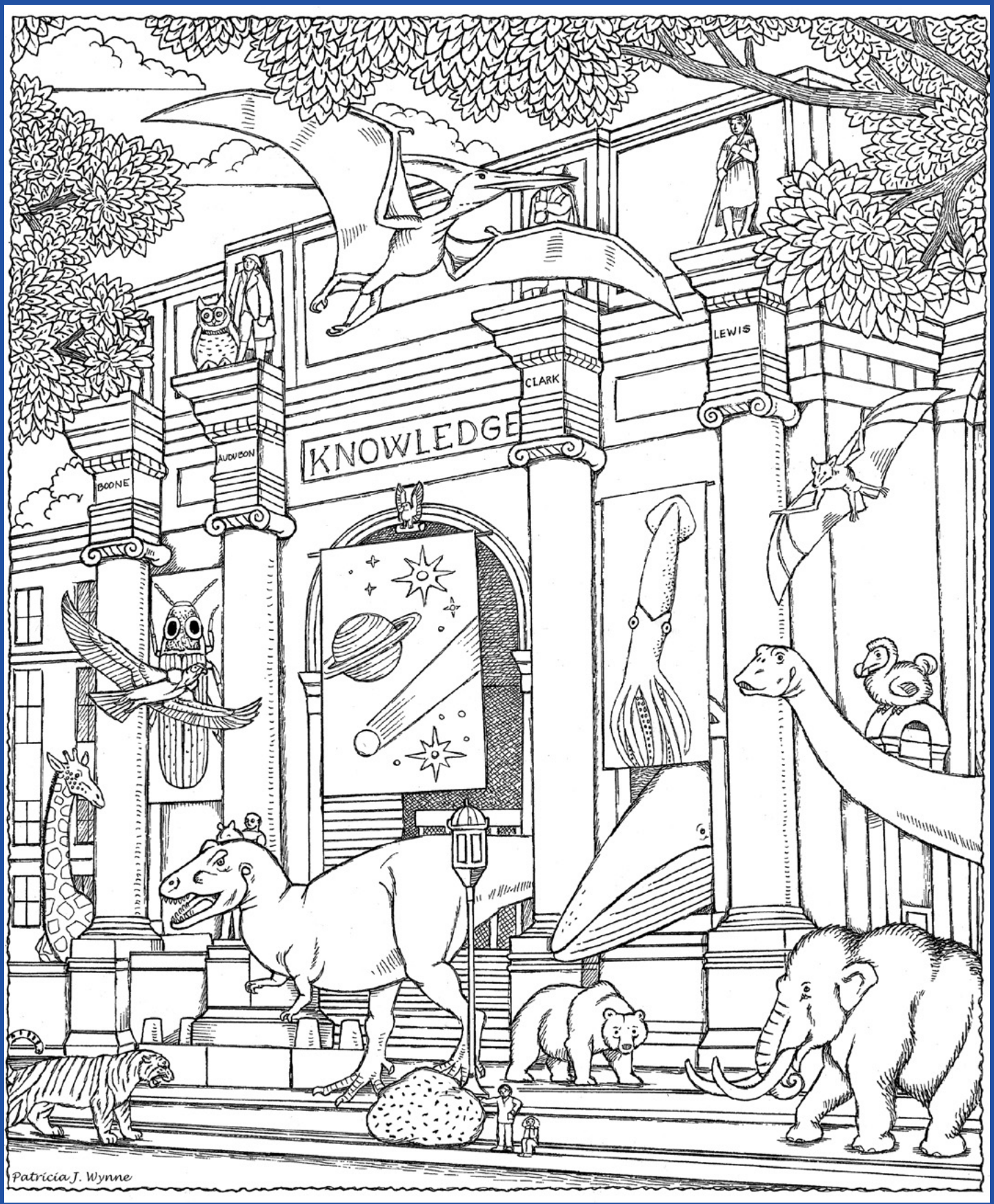
Your teacher will give you Super Saver Vouchers: these are good for general admission plus six special exhibitions, such as the IMAX movie, a temporary exhibit, or the butterfly conservatory. This voucher can be used at any time in the coming year.

To redeem these vouchers:

1. Enter the Museum through either the main entrance on Central Park West or the Planetarium at 81st street.
2. Proceed to the ticketing desk marked "City Pass."

Next time you're here, please visit us in the Discovery Room. This space is free with admission. The Discovery Room offers families an interactive gateway to the wonders of the Museum and a hands-on, behind-the-scenes look at its science. Every major field of Museum science and research, from anthropology to zoology, is represented. Children, accompanied by adults, can explore an array of artifacts and specimens, puzzles, and scientific challenges.

During the school year, the Discovery Room is open on Monday-Thursday from 1:30 pm - 5:10 pm, closed Friday, and open Saturday, Sunday, and public school holidays from 10:30 am - 1:25 pm and 2:15 pm - 5:10 pm.



Thanks for visiting! Come back soon.

www.amnh.org

Lesson Name: Our Senses

LESSON TYPE: SCIENCE

Culminating Experience Unit of Study: My Five Senses	Essential Question: How do we use our senses to explore, investigate and understand the world around us?
Objective: Children will use their five senses to explore the Museum exhibit. Children will record and describe how they use their sense of touch, sight, smell, and hearing to experience the exhibit and to learn new information.	
PKFCC Focus Standard: PK.AL.4: Exhibits curiosity, interest, and willingness in learning new things and having new experiences. **Additional PKFCC Standards:** PK.PDH.1: Uses senses to assist and guide learning. PK.CKW.1: Asks questions and makes predictions based on observations and manipulation of things and events in the environment. PK.CKW.2: Tests predictions through exploration and experimentation.	**Link to Authentic Assessment Systems:** **Completion of safari sheet** **Verbal sharing with peers**
Materials: Safari vests, safari sheet, sensory bins, instruments, scents and match, secret box, sensory books, etc.	**Vocabulary:** Senses, hear, taste, touch, smell, see, explore, science

Procedure:

Hook:

Enter Museum

Beginning:

9:10-9:15 Welcome Meeting

- Where are you all from? Who are you?
- Where are we today? - Museum of Natural History – Who has been here before? (Thumbs up thumbs down including parents) – What can you see/do here?
- A lot of people who do science work here and today we are going to do science
- To do science, we need something very important. Our senses (review senses -(associate movement with senses – e.g. sense of smell, touch nose)

- Senses help us to learn new things
- Introduce safari – What senses do you use and how do they help you learn?
- Explain safari vests and sheet
    - Be explicit about the parent's role here

Middle:

9:15-10:00 Safari:

- Visit *Senses: An Immersive Experience*
- Students will work with their adult learning partner to explore the exhibit and complete their safari sheet
- Teachers should maintain group flow, pointing out relevant stops, especially as they relate to the safari sheet

10:00-10:35 Free Exploration:

Tables are set up for you to explore, as you do, think about what you are using to help you learn about or experience what is on the tables

- Be explicit about parents' role here – learning partners, explore with child
- Sensory bin (sand, gems, rocks, shells) – sorting (math connections)
- Sound shakers/instruments
- Scents and match
- Secret box touch
- Books (literacy connections)

End:

10:35-10:40 Closing Meeting

- Review activities from the day - safari, free exploration
- What senses were used? Did you do something similar during exploration as in the hall?
- Turn and talk with adult - what was your favorite part?
- Connect to home and school? - where else do you use your senses (e.g cooking, painting, reading a book, etc.)

10:40 – 10:50 Feature Creature: (Can make a little longer, if you would like to share 2 animals!)

- Students will meet some of the classroom animals (possible – turtle, snake, gecko, walking stick)
- We will compare our own senses to the animals - how do they explore the world?

10:50-11:00 Bathroom and Buses

Send Home/Family Engagement:

- Moon sand recipe

8 cups of flour & 1 cup of oil (we used baby oil). Mix it up really well until all of the oil is incorporated into the flour. It will still look like flour (albeit full of teeny tiny lumps from the bits of oil), but it is moldable just like Moon Sand! **https://www.happinessishomemade.net/easy-diy-homemade-moon-sand/**
Assessment: Completion of safari sheets and verbal sharing with peers.
Differentiation: **For children who need additional support:** One to one adult-child interactions will allow for children to have rich scaffolding, if needed. - Will have an alternative space for children unable to enter the senses exhibit. (Still thinking about this piece) **For children who are ready for a challenge:** One to one adult-child interactions will allow for children to have enriching experiences, if ready.
Children with IEPs:
Children whose home language is a language other than English:
Teacher Tip:
Teacher Reflection:

Assessment Opportunity

[LESSON TYPE]: [LESSON NAME]

PKFCC Focus Standard:

Authentic Assessment Alignment:

Child's Name	Assessment Question #1	Assessmen	

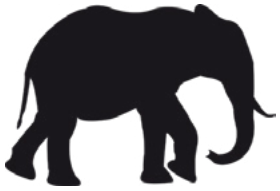
My Senses

AMERICAN MUSEUM OF NATURAL HISTORY

Name:_____

In the color room, you will **see** a variety of animals, don't you agree?

Look for the animals below on the walls, circle the ones you find.



What other animals can you find?

In the speaker room, you will **hear** different sounds to test your ear.

Draw a picture of one object or animal that makes the sound you hear.

In the feeling room, you will **touch** many textures, but not too much!

Choose a texture in the room. Write some words that describe how it feels when you touch it.

In the chocolate room, you will **smell** scents that make you smile or yell.

Which smell is your favorite?

Which smell is your least favorite?

In the art room, you will **create** your own designs, they will be great!

Use the tiles to create your own design. What did you make?

My Senses

AMERICAN MUSEUM OF NATURAL HISTORY

Today in the Museum's special Hall,
you used your **senses,** but not them all.
Circle the sense you did not use in the hall today.

Oh, what fun we've had today,
using our **senses** in such a great way.
Draw a picture below of you and your grown-up partner using one of your senses in the Museum's special Hall.

Program Calendar for Supporting Teachers' use of Active Science Learning with PreK Students and their Families at School, Museums, and Home

	GODDARD RIVERSIDE HEAD START		BLOOMINGDALE FAMILY PROGRAM, PS84, PS 111	
	Teacher Learning Activities	**Family Engaging Activities**	**Teacher Learning Activities**	**Family Engaging Activities**
August			B, DOE: Meet and Greet	
September		Parent Orientation Family Fun Night	B, DOE: Teacher Learning Session - Senses, Intro to Characteristics of EC Science Learning	B, DOE: Parent Orientation
October	Teacher Learning Session - Culture and All About Me	Butterfuly Photo Op Weekly Classes		
November		Origami Tree Lighting Weekly Classes	B, DOE: Teacher Learning Session - Prepare for Fall Trips	
December		Weekly Classes		DOE: Class Trip to Museum
January	95th Street Teacher Learning Session - Intro to Characteristics of EC Science Learning	Weekly Classes	DOE: Reflection Session	B: Class Trip to Museum
Feburary	Teacher Learning Session - Dinosaurs	Weekly Classes		
March	95th Street Teacher Learning Session - Plan to lead at AMNH	Weekly Classes	B: Reflection Session B,DOE: Teacher Learning Session - Change and Growth all Around Me	DOE: Family Fun Night
April	95th Street Teacher Learning Session - Birds & Logistics for Graduation	Weekly Classes	B, DOE: Teacher Learning Session - Understanding & Sharing Our Classrooms	B: Family Fun Night
May	Teacher Learning Session - Insects	Weekly Classes	B, DOE: Teacher Learning Session - Prepare for Spring Trips	B, DOE: Meet and Greet
June		Graduation	B, DOE: Reflection Session	B, DOE: Class Trip to Museum

The following activities were part of this project throughout the year:

- Launch convening (June 2017) and reconvening of adminstrators (June 2018)
- As needed, adminstrator meetings to check in and reflect on the work
- Occasional classroom observations as related to the teacher learning activities

B-BLOOMINGDALE
DOE - PS 84, PS 111