Early Childhood Science Learning

Developing Social, Language and Psychomotor Skills in Preschool Place at the New York Hall of Science

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Executive Summary

The purpose of this study is to explore children's learning in Preschool Place at the New York Hall of Science. The research focuses on two exhibit modules—the Train Table and Ball Run—to examine their effective on fostering development of:

- Language
- Social skills
- Psychomotor skills

In addition, we study explore these exhibits' contribution to cognitive gains in science. The Hall will use findings to develop effective learning goals for specific exhibits and as a framework for creating new preschool exhibits and programs.

Methodology

Two approaches were used, one focusing on the museum's general audience, the second on families who participated in an extended experience. General audience data, consisting of observations and interviews, were collected on Friday afternoons, Saturdays, Sundays and holidays from December 12, 2008, through February 1, 2009. The extended family experience took place on Monday, February 2, 9, 23 and March 9, 2009.

Findings: General Audience

Almost 130 children and their parents took part in the general audience segment of the study. Children's ages ranged from 2 to 5 years old. Some 25% were members and many others were frequent visitors; only 1 in 3 families were first-time visitors. Most children played alone; children who came together—siblings or friends—tended to play cooperatively.

Train Table

The 64 children timed while using the Train remained there from 1.5 to 45 minutes; the average time was almost 11 minutes. The observation protocol was precoded to capture conversations, social interactions and psychomotor activity. Children learn quickly that they must share with others. Most adults tend to sit back while their children play, interfering only to correct inappropriate behavior. A few adults attempt to instruct them about some aspect of the activity. Some 4 in 10 children talked as they played or uttered train-related sounds (choo-choo, beep-

beep, woosh-woosh and zoom-zoomr. There was conspicuous gender-based variation in behavior. More than twice as many boys as girls engaged with the Train and engaged for longer intervals.

The majority of children complete the full track loop around the table at least once. Fewer than half the children played with other items on the table—a garage and a stop-and-go sign.

The train cars connect to each other by embedded magnets. Most of the children were able to connect the cars using the magnets and did so repeatedly. Many of them seemed to understand polarity intuitively, reversing the direction of two cars whose magnets repelled each other to establish the attraction.

Ball Run

Children remained at the Ball Run longer than one might expect, though not as long as at the Train Table. Their time at the Ball Run ranged from 1.33 minutes to 28 minutes and averaged The difference in boys' and girls' time at the Ball Run was not as marked as at the Train Table.

Minimal social interaction occurred among children who did not know each other prior to the visit; the general tone around this activity was more cooperative and less combative than observed at the Train Table.

The Ball Run prompted more adult-child interaction than the Train Table. Several caregivers encouraged children's physical and intellectual engagement, such as anticipating where the balls would come out.

Children engage with this seemingly repetitive activity for a long time, placing balls in the same hole or trying out different placements. Often children start out using one ball over and over, then move on to experiment with several balls, either putting them in the same hole or dropping them in parallel paths. Virtually all the children placed balls in accessible holes, and 8 in 10 attempted to reach the higher holes, moving a large cube so that they can climb up and reach one. Several children attempted to throw a ball into the upper holes with varying degrees of success.

Parents/caregivers of observed children were asked to participate. The response rate was 86%. The most frequent reason given for bringing children was learning; the second was "It's fun" and the third, "It's something to do." Analysis of responses referred to our research topics: social, psychomotor and language skills as well as learning in general and learning science.

When discussing what children learn in Preschool Place, adults referred directly to our targeted topics. The most frequently cited learning outcome was developing social skills—learning to share. One in 4 caregivers said they brought children to Preschool Place to learn about science, particularly "cause and effect." One in 5 respondents cited psychomotor skills.

The Train Table can promote the skills under investigation—sharing/social skills, how to put things together/psychomotor skills, science and imaginary play (language was not mentioned). The Ball Run promotes a scientific world view—how to make meaning of phenomena—rather than specific social or psychomotor skills. "Cause and effect" was cited frequently.

Findings from Class

The class consisted of 2 boys and 3 girls, with their significant adults. The first half hour of class was reserved for free exploration, with train- and ball-themed items placed strategically. Week 1 introduced the concept "how do things move?" Week 2 covered circles, week 3 balls, bouncing and "gravity," and week 4 wrapped up with trains.

Caregivers were our primary source of information on the class's more sustained impact on the children. In Preschool Place, children can learn social skills—"Interacting with other kids, taking turns;" Psychomotor skills—"Sensory development, fine motor skills." Language—"Books, although we never sit down to read." They learn about science and engage in imaginative play.

Most adults thought all the class activities were "very important" for learning, particularly free exploratory time and hands-on experiments. Story time was seen as the least important activity.

Class parents' interviews provided valuable information about sustained learning because they not only observed their children at home, but unlike typical preschool programs, they participated in the class experience. The evidence indicates that children in a sustained program use their developing psychomotor and language skills beyond the museum setting. This research underscores the crucial role parents play in skills development and early science learning.

The pilot class developed for this research project suggests that a sustained preschool science experience is effective. Children enjoy it and parents can see children's development over time.. Parents said they would participate in a similar program if offered.

The reader is encouraged to read on for a more complete understanding of the study.

Introduction

In recent years, the New York Hall of Science (NYHOS) has experienced substantial growth in its preschool visitor population, leading the Hall to develop exhibits and programs targeted at this audience segment. Before embarking on additional projects to serve its youngest visitors, the Hall's Education Department decided to conduct research on young children's learning.

There is an urgent need today to attract students to STEM subjects. Learning research suggests that preschool children as young as 3 years old are capable of developing a "scientific worldview" based on their natural curiosity about how their world works (Chittenden, 2004). The mission of the NYHOS—"To bring the excitement and understanding of science and technology to children and their families by stimulating curiosity and providing creative, participatory ways to learn"—is ideally suited to respond to the need for science learning opportunities for young children. With support from the Altman Foundation, it aims to explore sustainable learning experiences for young children who participate in the Hall's preschool programming and exhibition areas.

The purpose of this study is to explore the impact of two exhibit modules in the Hall's Preschool Place—the Train Table and Ball Run—on children's learning. Although exhibits like these are fairly ubiquitous in museum spaces designed for the youngest visitors, little or no research exists to show how effective they are in fostering development of:

- Social skills
- Psychomotor skills
- Language

The research goal here is to investigate development of these skills, using the two exhibit elements as hubs for 1) children's social and physical interaction, and 2) conversations among children and between caregivers and children. In addition, we explore the extent to which these interactive exhibits contribute to early cognitive gains in science and the scientific process.

Findings will be used by the Hall to develop effective learning goals for specific exhibits and as a framework for creating new exhibits and preschool programs.

Methodology

Two methodological approaches were used, one focusing on the museum's general audience, the second on a group of families who participated in an extended experience.

1. Data collectors observed and interviewed families on days when the general audience (not school groups) typically visit the Hall. Data collection took place on Friday afternoons, when admission is free, Saturdays, Sundays and holidays from December 12, 2008, through February 1, 2009.

   The protocol began with observation of a child who approached the Train Table or Ball Run. The criteria for selecting subjects were that they be: 1) between 2 and 6 years old (confirmed by caregivers) and 2) engaged in the activity for at least one minute.[1] Time spent was measured and behaviors noted on a precoded data collection instrument. Verbatim transcripts of overheard conversations were made. When the child was ready to move on to another activity, the data collector asked the child's caregiver if he or she would answer a few questions for a research project on learning in museums.

2. Parents of 4-year-olds were invited to the Hall to participate in a class, a pilot project, focusing on intergenerational science learning. Age 4 was selected 1) to limit the class to children of similar developmental levels, 2) because 4-year-olds were likely to be able to express themselves verbally and 3) because 5-year-olds would be in kindergarten and unavailable to attend class. Five families accepted and four classes took place on Monday mornings from 11:00 to 12:30, on February 2, 9, 23 and March 9, 2009. Classes were held in Preschool Place where the Train Table and Ball Run are located. Children were encouraged to explore the exhibits during half an hour of free play, which was followed by organized activities designed around themes related to the two targeted exhibit elements. Researchers observed and interviewed the children individually and the parents individually and as a group.

Findings are reported in two sections based on the two approaches—general audience and class participation. A third section offers discussion, and finally we recommend options for future exhibit and program development. (Instruments can be found in appendix 2.)

[1] Average time on task cannot be considered applicable to all children who use these exhibits: many children stop for a few seconds, but they were ineligible for this research sample because we wanted to investigate more sustained experiences with the exhibits.

Findings

I. General Audience

Almost 130 children and their parents took part in the general audience segment of the study: 69 children were observed while using the Train Table and 60 using the Ball Run. The Train Table sample consisted of 70% boys and 30% girls, and the Ball Run sample 64% boys and 36%girls. No effort was made to stratify the samples: children who engaged with the activity for 1 minute or more were selected for observation. Children's ages ranged from 2 to 5 years old (one 6-year-old was observed using the Ball Run). Figures 1 and 2 illustrate the sample's age distribution.

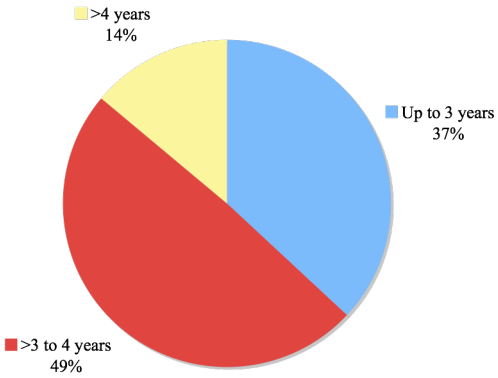

Figure 1. Age of Children: Train Table (N=66)

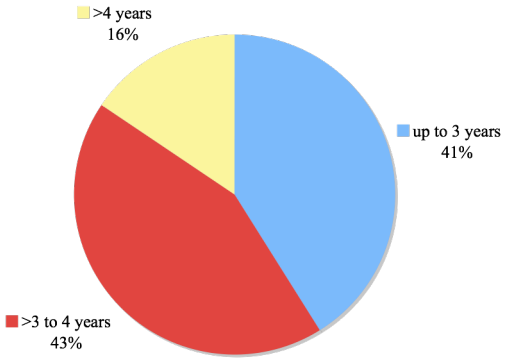

Figure 2. Age of Children: Ball Run (N=51)

Train Table

The Train Table measures about 4 by 6 feet and sits about 2 feet off the floor. Tracks are set up and fixed in looping configurations, with bridges and underpasses (see figure 3). The surrounds are painted to resemble a landscape. A few structures, including a garage and a stop/go sign, are attached to the table. There is ample room for several children to participate simultaneously.

Figure 3. Train Table

Observation Results

Preschool Place tended to be crowded during observation periods, which took place on free Friday afternoons and weekends. The number of visitors at any one time ranged from just a few to 20 adults and 30 children (a rare occurrence) and averaged approximately 8 adults and 9 children.

Time on Task

The 64 children timed while using the Train remained there from 1.5 to 45 minutes (figure 4). Nine children spent from 20 to 45 minutes at the Train; the average time was almost 11 minutes.[2]

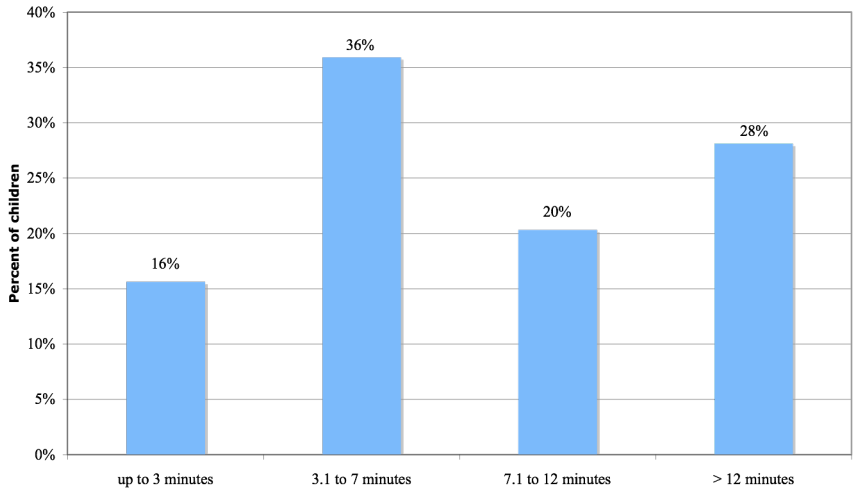

Figure 4. Time at Train Table (N=64)

Figure 5 compares boys' and girls' time at the Train Table: twice as many boys as girls spent more than 12 minutes at the Train Table.

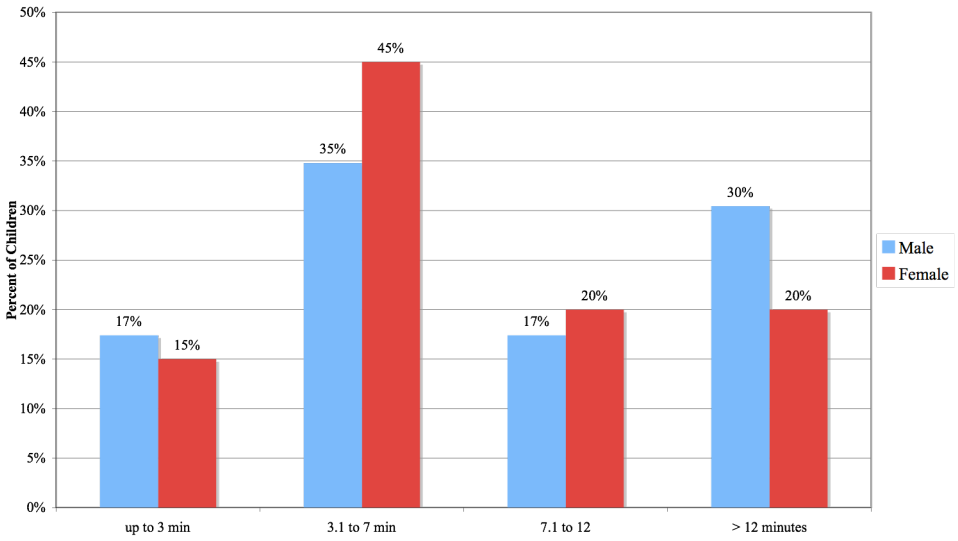

Figure 5. Time at Train Table by Gender (N=64)

[2] Because only those who engaged with the exhibit for at least 1 minute were timed, average time may be longer than for a randomly selected sample.

The observation protocol was precoded to capture conversations and nonverbal communication, social interactions and psychomotor activity (physical manipulation of the objects on the Train Table). Data analysis proved unable to separate verbal from social interaction, thus the findings are considered together below.

Social and verbal interactions

Preschool Place is staffed; however, typically only two Explainers work in the two large rooms with many activities going on simultaneously. Consequently parents are the principal instructors and behavior monitors in the space. Most children (74%) play alone at the Train; even when other children are at the table, parallel play is the norm for 60% of the children. Many children ignore their peers or watch them warily for attempts to take their trains. Watching also generates imitative behaviors, suggesting that although they do not acknowledge each other, children are learning from each other. The children seem to be aware that they must share the space and its items; although they all want to use as many cars as possible, they learn quickly that they have to relinquish at least one or two of them to others.

Interviews with adults revealed that most of the families are frequent visitors: 25% were members and many others visit often; only 1 in 3 families were first-time visitors. Thus the majority of participants were familiar with Preschool Place and its social requirement, sharing.

We did observe occasional cooperative social interactions among half the children, for example, helping another child connect train cars. Some 4 in 10 children had negative interactions, such as grabbing someone else's cars or crying when theirs were taken away. Several children had both cooperative and negative interactions. Parents intervened as needed to check hoarding or aggressive behavior. Findings regarding social interactions were not age related; similar behaviors were observed in 2-, 3-, 4- and 5-year-olds.

Children who came together—siblings or friends—tended to play cooperatively. One pair of 4-year-old friends enjoyed moving their trains on collision course, chasing each other's trains, laughing all the while. Two brothers talked and shared their cars. Girls were less frequently assertive: a 4-year-old girl who found someone else's cars blocking her path, rammed the cars, making the other child cry. Another 4-year-old girl took cars she wanted from her little sister, playing with her but ignoring other children.

There was conspicuous gender-based variation in behavior. More than twice as many boys as girls became engaged with the Train and remained engaged for longer intervals. Girls occasionally proved quite adept at keeping their cars, if necessary clutching them to their chest. But they were not as assertive as the boys. Girls were likely to give up and leave the table when confronted by a boy. A NYHOS member who often brings her granddaughter commented on this: "She moved on from the last visit where she just watched the boys using the train," noting that boys typically dominate the Train Table. A 4½ -year-old girl said, "No," softly when another child tried to take one of her trains, but another girl responded assertively when her train was threatened by a boy: "Hey, I'm playing with this!" A girl almost 4 years old talked to and played with younger boys at the Train Table, sharing but bossy and controlling.

Some 4 in 10 children talked as they played with the trains, though what they said was often inaudible. Many children used train-related vocabulary or sounds; others referred to items on the table, most often talking to themselves or their adult caregiver. A 4-year-old boy who remained engaged for 45 minutes quoted sentences he must have heard on the NYC subway trains, "This is the last stop on this train…"

Examples of conversation

"Giant." (as she strings more trains together). F 2½

"It's too big." (when trying to get the big car under the overpass). F 3

"Going train! Go forward to me!" M 3½

The stop sign is up, you can't go. M 4

"We almost slammed in [to the tunnel]!" M 4

About 1 in 4 children uttered train-related sounds as they played. These were what one might expect—choo-choo, beep-beep, woosh-woosh and zoom-zoom—suggesting that the children were thinking of motion and speed. Some children used their voices to utter joyful sounds or exclamations of frustration—whining or crying—if another child interfered with their play.

Occasionally verbal communication occurred between children. When it was cooperative, the children seemed to know each other or were responding to prompting from an adult. More often the communication was used to reinforce territory or ownership of a vehicle. For example, a 5-year-old boy said, "Hey!" when another child tried to touch the trains he was playing with, and a 3-year-old boy negotiated, "You go on that one, I'll go on this one."

Interaction with Adults

Most adults tended to sit back while their children played with the trains, interfering only to correct inappropriate behavior. A few adults played with their children and attempted to instruct them about some aspect of the activity. For example, a father tried to explain polarity to his 4½ -year-old son while the boy used the train's magnets to connect two cars. A 4-year-old girl chatted with her mother while playing with the garage, parking all the cars on its roof. A 3½ -year-old boy said, "Mom, will you play with me?" He wanted her to take the train from where it stood across the table and move it to where he could reach it.

Most adult participation involved peace-making to avoid conflict: A dad pointed out another train to his 4-year-old son when another child took his: "There is another train over there." A 3-year-old boy looked to his mother when a child got in his way. She advised, "Say 'excuse me' to the other child." Several children spoke with their parents in a language other than English, highlighting the diversity of the Hall's general audience. When another child asked her son if she could play with him, his mother told him to say, "I don't speak English."

Psychomotor observations

Virtually all the children move one or more train cars on the track using one hand. Half of them use two hands, particularly when many cars were attached. The majority of children (about 60%) completed the full track loop around the table at least once. A 3½ -year-old boy spent more than half an hour circling the table, pushing his trains around the loop.

Fewer than half the children (43%) played with other items on the table—a garage and a stop-and-go sign. The garage occupied children who could not find space on the tracks. For example, the 4-year-old girl mentioned above drove cars around the roof of the garage. A number of children experimentally pressed buttons located on top of the garage, but the buttons didn't seem to affect anything. Many children turned the stop/go sign as their train passed by, suggesting that they were engaging in imaginative play, perhaps pretending that the stop-and-go sign was similar to the red and green lights at street crossings.

Fewer than half the children (4 in 10) let go of the train as it descended one of the bridges. One, a 4-year-old boy, let the train go for a moment and noticed that it went downhill by itself, then tried the maneuver again purposefully. Another boy (2½ years old) raised his hands as the train went downhill saying, "Zoom." Many children would not let go of their train cars for fear of

losing them to another child. The Train Table is too wide for a child to reach across: a 4-year-old girl, trying to keep ownership of her train, pushed it to the top of a hill, let it go and ran quickly to the other side to catch it as it slid toward her.

Magnetism

The train cars connect to each other by embedded magnets. We observed that most of the children (74%) were able to connect the cars using the magnets and did so repeatedly. Many of them (46%) seemed to understand polarity intuitively: when a child as young as 2½ years old attempted to attach two cars whose magnets repelled each other, he turned one of the cars around to establish the attraction. A data collector noted: "He looks puzzled when he tries to put trains together and they don't stick. He moves the positions until they do. When this happens again, he quickly flips the cars around so the magnets will stick." This sequence occurred with 3- and 4-year-olds as well.

Data collectors asked older children what made the cars stick together but they declined to answer, either because of shyness or inability to verbalize the concept. As noted above, one of the fathers was overheard explaining polarity to his 4½ -year-old son.

Problem solving: underpass

Several of the cars on the tracks came from another set and were too tall to fit under the bridges as they moved around the track loops. After trying to jam a too-tall locomotive through, children used several psychomotor strategies to cope with the problem. One strategy was to back up and retreat. Another was to jump the entire train over the offending underpass. A third technique: if the large car was the engine, the child jumped it over and slid the other cars through to catch it. When confronted with the obstacle, one child stopped, backed up his cars until he came to an intersection, and then moved forward on a different track without an underpass. Lastly, a few children simply removed the large cars and put them in the garage, continuing with only the cars that fit.

Problem solving: crowds

Another type of problem necessitated social skills: coping with crowded conditions. One way to cope was to leave the table when it was crowded; another was to move cars to another section of track that was not occupied. Some children could not cope and had to be restrained by parents. As a data collector reported: "Two brothers were using all the trains at one point when the room was

very crowded. Other children and parents tried to get them to share but they wouldn't. When the conflict started escalating, the boys' mother pulled them away, making them leave. The boys went into full temper-tantrum mode, screaming and kicking as she pulled them away from the table."

Inappropriate play

Occasionally one of the children removed trains from the track and even from the table. Sometimes this was in fun or an attempt to use a car in another activity such as dropping it into the Ball Run. On a few occasions, children took the cars away from the table out of frustration or anger. When cars were removed, parents intervened to bring them back.

Ball Run

The Ball Run is fixed to a wall, about 6 feet wide and 5 feet high. It has many openings through which children can drop colorful balls and watch them as they bounce around obstacles behind the transparent front panel (see figure 6). There is ample room for several children to participate simultaneously. To reach the openings at the top, children need assistance.

Figure 6. Ball Run

Observation Results

Observations tended to take place when the space was crowded—free Friday afternoons, Saturdays and Sundays—winter weekends. The number of adults and children in the room at any time ranged from just 5 of each to more than 20 adults and 27 children.

Time on Task

Children remained at the Ball Run longer than one might expect, though not as long as at the Train Table. Their time at the Ball Run ranged from 1.33 minutes to 28 minutes and averaged just over 5 minutes. Figure 7 below illustrates the time distribution and figure 8, time by gender.

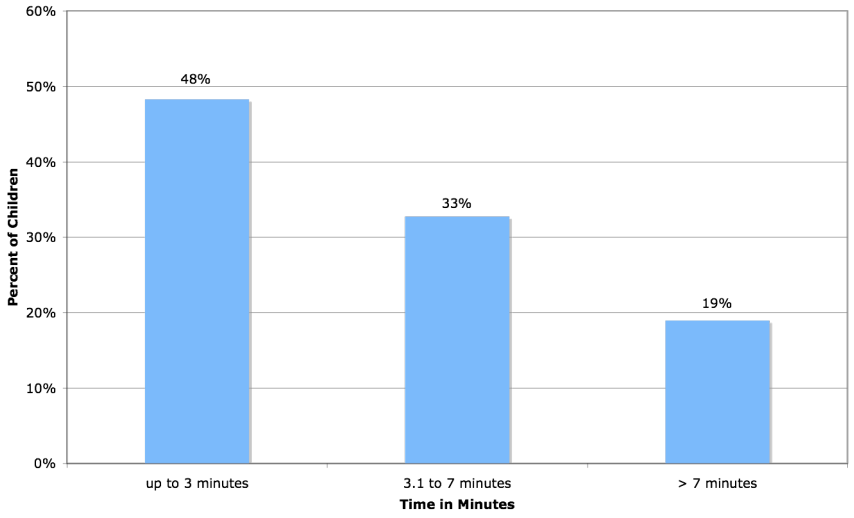

Figure 7. Time Playing with Ball Run (N=58)

Time data illustrate trends: after long stints timing a single child, data collectors were instructed to move on and note "more than X minutes." Thus times may have been longer than reported.

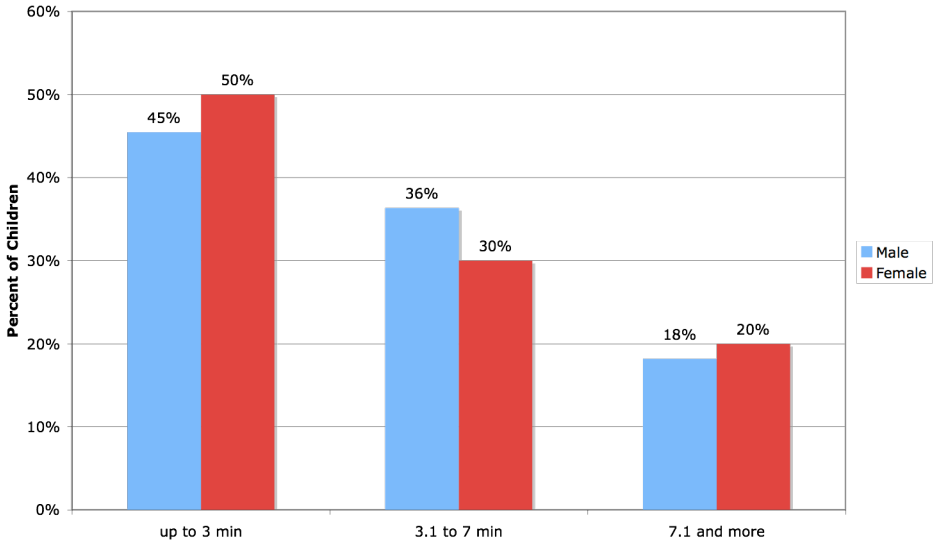

Figure 8. Time at Ball Run by Gender (N=53)

The difference in boys' and girls' time at the Ball Run was not as marked as at the Train Table.

A precoded observation protocol was designed to capture children's verbal and nonverbal communication, social interactions and psychomotor activity (physical activity related to the Ball Run). As with the Train data, it was impossible to separate verbal from social interaction, thus the findings are considered together below.

Social and Verbal Interactions

Minimal social interaction occurred among children who did not know each other prior to the visit—3 in 4 children played alone. When the space was crowded, parallel play prevailed. The general tone around this activity was more cooperative and less combative than observed at the Train Table. Several children communicated cooperatively, for example, offering a ball to a child who had none. This type of behavior was rarely seen at the Train Table. Children watched patiently and waited for a chance to participate. For example, a 4-year-old boy helped a child when his ball rolled away and another child was about to take it saying, "Here you go." A child brought a block over and showed another child how he could use it to reach a higher opening. Children who came together played together, and sometimes that included keeping other children from using the equipment.

Some 4 in 10 children talked as they played but mostly to themselves or to their adult caregiver. Colors were mentioned, for example, a 3-year-old boy said about himself, "Max steps on the blue [block]," and another boy holding a yellow ball said "yellow." Conversing with his father, a 4 ½ -year-old boy said, "How about this one," as he put a ball in another hole. Children spoke to their families in several different languages, suggesting that child-to-child verbal communication could be difficult in this diverse community. In addition to excited whoops and exclamations, a few 3- and 4-year-old girls verbalized their enthusiasm:

"I want to put it in a hole." F 3
"Ready! Set! Go! I want to do it!" F 4
"Bounce, bounce, bounce." F 3

As they did at the Train Table, parents assumed the role of checking inappropriate behavior and insisting their child share with others. A 3½ -year-old's mom told him that he had enough balls. He replied, "No it's not." His mom explained, "You have to share with other people."

Adult interaction

The Ball Run prompted considerably more adult-child interaction than the Train Table. Several caregivers encouraged children's physical and intellectual engagement, such as anticipating where the balls would come out. For example, a data collector noted: "A 4-year-old boy and his dad were communicating throughout their time at the Ball Run. Father suggested where to place balls and, scaffolding the child's knowledge, tried to help him determine which ball would drop down to the bottom first. The child was not very verbal and made mostly happy sounds, maintaining eye contact with his father and following the father's directions about how and where to place balls." A girl's mother suggested that she put a ball in another hole and the child said. "OK." Then mom said, "Try the left one, try the right one…" and she followed those directions. Another dad said, "Where do you want to put it next?" A few parents engaged their children in a game to see whose ball would come down first. Some parents of the youngest asked children to name the colors of the balls.

A 3-year-old boy stood on a large block to reach the higher openings but had some difficulty keeping his balance and called to his mom for help. She stood near him and asked him questions like, "How many balls do you have?" "Do you want to put them in the middle run?" The two also raced balls by putting them in the top holes at the same time. When her daughter fell off a block, a mom cheers and said, "Yay, you did it!" As his small son was standing on the edge of the block, a dad said, "That's a little dangerous, throw them in instead." The boy threw the ball enthusiastically, often missing, as the dad said encouraging things; when the ball went in, dad said, "Nice, good shot, buddy!" several times. A father encouraged his 3-year-old daughter to put balls in the higher holes; she handed the balls to him so he could put them in and she could watch them descend. Many adult comments consisted of helpful suggestions for using the Ball Run.

Adult comments

"Do you want to try that in a different place?"

"Here, get up on the step. There are two more over there." (Mom)

Children's comments to adults consisted mostly of descriptions of what they were doing.

Children's comments

"These balls are going down, down, down, down. Look at all of them. They're bouncing." M 4

"I put it in the middle then it goes here" (pointing down). M

Several children called on parents who were often too ready to provide help instead of letting the child work out a solution. A mom said, “Here, come stand on here,” as she set a block for her son to stand on. A 3½ -year-old boy had his mom pick him up repeatedly so that he could put balls into the top holes; she finally brought over a block to help him climb up and reach it himself.

Psychomotor Observations

Children engaged with this seemingly repetitive activity for a long time, placing balls in the same hole or trying out different placements. Often children started out using one ball over and over, then moved on to experiment with several balls, either putting them in the same hole or dropping them in parallel paths. They enjoyed picking up many balls at the same time—3 in 4 children picked up multiple balls—struggling to climb onto the blocks without using their arms for balance because their hands clutched the balls to their chests. A 4-year-old girl watched as her mom dropped balls and waited at the bottom for them to come out. Most children were able to anticipate correctly where the balls would appear at the bottom of the run; however, when asked, they were unable to explain how they knew this.

Problem solving

The uppermost openings in the Ball Run are too high for children to reach, yet they all want to drop their balls there. Figuring out how to do this on one’s own requires serious problem-solving strategies. There are large blocks nearby; resourceful children moved one or more close to the Ball Run so that they could climb up and reach the highest holes.

Virtually all the children placed balls in accessible holes, and 8 in 10 attempted to find a solution for reaching the higher holes. The solution was typically to stand on a block, either by moving it or finding one already in place. Some children figured out what to do, others needed a caregiver’s help. The blocks were large and unwieldy, and usually required adult help to move them to the right place. A few caregivers simply lifted a child so he or she could drop the ball in the hole. One child tried to climb up the Ball Run structure itself to reach an upper hole. Several children attempted to throw a ball into the upper holes with varying degrees of success.

Inappropriate play

A few children took balls away from the Run, either to play with them elsewhere or to prevent others from playing with them. Two children experimented with putting other objects in the Ball Run openings to see what would happen.

General Audience Interview Findings

All parents/caregivers of observed children were asked to answer a few questions to help with the research project. The response rate was high—59 Train Table interviews, an 87% response rate; 52 Ball Run interviews, an 86% response rate. The interview consisted of open-ended questions asking about adults' expectations for the visit and what they thought children were learning in Preschool Place generally and at the Train Table and Ball Run specifically. Questions that apply to Preschool Place generally merge the two samples for analysis; questions that apply to specific exhibits disaggregate the samples.

Preschool children are not verbally confident or mature enough to explain what they are doing and why (we asked them to no avail), but parents and caregivers provide valuable insights; they know their charges well and see them in a variety of settings. The interview sample consisted of 111 caregivers—mothers, fathers, grandmothers, grandfathers and one babysitter. Female caregivers outnumbered their male counterparts by almost 2 to 1. Fewer than 3 in 10 (29%) were first-time visitors and about 1 in 4 (22%) were NYHOS members. A number of families were frequent visitors, having visited from just twice to once weekly since January 2009. The majority of families were from Queens (see appendix 1 for demographic data).

Why do they bring their children?

The most frequent reason caregivers gave for bringing children to Preschool Place was learning (30%, see table 1). The second most frequent response was "It's fun, the children like it here" (24%). The third popular answer was, "It's something to do"—when the weather is too cold to be outdoors, so the kids don't watch TV all day, something for children of various ages in the household (24%). Analysis of responses measured references to our research topics: social, psychomotor and language skills as well as learning in general and learning science in particular.

Psychomotor comments referred to activity and hands-on opportunities; comments referring to sharing and playing with other children were coded as social skill development; Language skills were not mentioned in this context or as a reason for coming to the museum. "Safe, age appropriate" refers to the confined nature of Preschool Place compared to the openness of the rest of the museum. Comments coded "Other" were either irrelevant or suggested that the respondent had not understood the question. Many caregivers provided several reasons for bringing children to Preschool Place. Examples of comments follow Table 1.

Table 1. Reasons for Bringing Child to Preschool Place

Reason for Coming	Number of Responses (N=111)	Percent*
Learning/science	32	29%
It's fun, children like to come	27	24%
Something to do	26	23%
Psychomotor skills	18	16%
Social skills	14	13%
Safe, age appropriate	6	5%
Other	5	5%
Free admission today	2	2%

*Percents add to >100 due to multiple responses

Examples of caregivers' responses by category, although each includes more than one category:

Learning

"For socialization and a strong foundation for science. There are not a lot of places like this."

"He's 3½ and starting to be interested in science, rocket ships."

"I like that they learn through play. There's always something different they can do."

"…to explore things, learn things without my instruction. To discover things himself."

"He has a good time playing and learning science and mechanics."

Social and psychomotor skills

"Interactive play; she's shy with other kids, this gets her in contact with kids."

"There are lots of activities; he gets to run around. Also, socialization—they learn from each other."

"He loves the machines and working with other kids."

"There are lots of activities, he gets to run around. Also, socialization—they learn from each other."

"It's so stimulating and interactive. She never gets bored."

What can children learn in Preschool Place?

In response to a query about learning in the space, the adults referred directly to our targeted topics (table 2). The most frequently cited learning outcome (58%) was developing social skills—learning to share and play with other children, particularly for children not attending preschool. Respondents mentioned learning in general and science, mathematics and other "academic" subjects specifically. Responses coded as psychomotor development referred to

hand-eye coordination and developing muscle control. People who mentioned the books in Preschool Place were coded as learning language.

Table 2. What Children Can Learn in Preschool Place

Children can learn…	**Number (N=111)**	**Percent**
Social skills	64	58%
Other learning	42	38%
Science learning	25	23%
Psychomotor skills	22	20%
Language	2	2%

*Percents add to >100 due to multiple responses

Social skills

"They play together. The train has only so many cars so you have to share."

"Taking turns, saying "I'm sorry." She's not in school."

"Collaborative play."

"Socializing in a group environment."

One in 4 caregivers said they brought children to Preschool Place to learn about science (23%) and they cited several concepts that children seemed to be grasping, particularly "cause and effect."

Science

"Cause and effect. Seeing the relationship between things and how they interact."

"Construction. Math."

"Gravity, movement, controlling objects."

"Seeing the way things work."

"Math, science, gravity. Lots of science."

"Mechanics."

"Experimenting."

"Pulleys, movement of materials."

Psychomotor skills were cited by 1 in 5 (20%) of the respondents, but they referred to specific physical performance goals.

Psychomotor skills

"Hand-eye coordination"

"Making things move."

"Fine motor skills, gross motor skills."

"Touch and see and feel, everything here is about touching."

Almost 4 in 10 respondents (38%) cited other things that children could learn in Preschool Place, many having to do with imaginative play and pretending. Respondents said that heir children could play with things in the museum that they couldn't have at home. A few people said they didn't think the children learned anything in the museum, they just had fun: "Watching the puppet show. Having fun, enjoying themselves; I'm not so into academic things for them right now."

Other things children can learn

"Being stimulated by different shapes and colors."

"Problem solving."

"Pretending."

"Movement. Imagination."

"Categorizing and sorting."

"Building, engineering, learning how to put things together."

"How to play independently, where I'm not following her around telling her what to do."

One of the fathers noted that it was interesting for him to interact with other parents in the Hall."

What were you thinking?

We asked caregivers, "What were you thinking as you watched your child playing?" When researching mother-child interaction in museums, Florence Beaumont (2006) discovered that this question produced powerful responses. In this study, 12 people said they were not thinking about anything—"Just zoning out," as one of them put it. Table 3 illustrates the results.

A number of caregivers (18%) said they were thinking about *what* and *how* their child was learning. In addition to social skills, caregivers observed their children's psychomotor development.

"Cause and effect.

"Her dexterity."

"I like that she was experimenting, putting harder and softer balls both in the same hole."

"His motor skills. Wondering what kind of choices he's making, interacting with something, like how to access the top hole."

"I'm happy with him figuring out the magnets and the polarization of the magnets."

"[I was thinking] that it's wonderful here and she learns so much more here than from reading a book."

Table 3. Caregivers' Thoughts While Watching Child Play

Thinking about…	**Number (N=111)**	**Percent***
Social interaction, sharing	25	23%
S/he is learning	20	18%
Specifics of what child is doing	19	17%
S/he is happy, having fun	18	16%
Nothing, zoning out	12	11%
Development, growth, change	5	5%
Let him alone	5	5%
Empathy with child	4	4%
Safety concerns	2	2%
Other	3	3%

*Percents add to >100 due to multiple responses

Almost 1 in 4 caregivers (23%) thought about social skills—how was the child interacting with other children? Was s/he sharing, playing with others? A major preoccupation for caregivers was to ensure that their child avoided conflict. One mother said, "[I'm thinking about] where he's going next; the social interactions: if he's going to take something from a kid or vice versa." The mother of a 3½ -year-old boy said, "Before he was 3 years old, he was always fighting. I was upset. Now I feel much better because he can share. … He's an only child and can play with kids here. I think that's why he's so happy here." The mother of a 4-year-old girl seemed to empathize with her daughter when she said, "[I was thinking about] how patient she is. She can build something and another child wrecks it, then she just starts over." Three adults said they try to leave their child alone to figure out how to handle social interactions, for example: "I like to leave him alone, let him figure it out. He had an older girl come over and try to take his trains and he figured out what to do."

Several people (17%) said they were thinking about what their child was doing specifically, for example:

"I love watching what he gravitates to, what he loves."

"He's creating his own universe; role-playing."

"I was noticing that he watches the ball as it goes down."

Two parents were thinking about how the Ball Run could be made more educational:

> "I want him to explore the relationship between the heights, want him to know that things don't drop down at the same speed. If there were some kind of dynamic, [something] they could control, that would teach them more."
>
> "Maybe they could have different size balls, different materials and see how the heavier ones would drop down faster."

Five people said that they thought about their child's development, observing changes in her or his interests, for example:

> "She never really plays with trains, she usually plays with dolls."
>
> "How long is he going to be obsessed with [trains]? Will he grow out of it?"
>
> "[I'm thinking about] what she's going to do in the future, what she's into."
>
> "That he's learning and developing right before my eyes!"

Several caregivers said they were thinking about how their child was enjoying him- or herself, having fun. A mother speaking about her 4½ -year-old son expressed it, "[I was thinking about] how calm he is, not nervous, just there calmly. He's in his world, comfortably playing."

Several caregivers remarked that they liked watching their children enjoy themselves:

> "I noticed he likes to hum when he enjoys what he's doing, and he was humming here
>
> "[I was thinking] how calm he is, not nervous, just there calmly. He's in his world, comfortably playing."

Two nervous parents were worried about safety, hoping their child would not fall off the blocks they were climbing on.

A few remarks suggested parents were empathizing with their child, for example: "This is the kind of thing I enjoyed as a kid."

Interview Findings Specific to Train Table

The majority of caregivers said their child had played with the Train before (59%). Why did they think he or she liked it? Most of the respondents said the child just loves trains—some broadened the idea to "anything that moves." A few respondents suggested that gender plays a role in children's love of trains: "He likes any cars, any trains. Maybe because he's a boy" (mother), and, "Boys are fascinated with how things move" (father). A grandmother remarked, "She usually watches, boys are usually playing with it. Today it's not crowded."

Likes the Train because…

"He likes to count them; move them around."

"The bridges are interesting."

"[He hasn't played with trains] as intensely as today, but it's familiar, it's fun to connect together and make a long train."

"He likes any vehicles, he likes the magnets—how they stick together."

Most of the boys and a few of the girls have a train set at home, but clearly the boys are the ones "obsessed with trains," as one father put it. In effect, the train gender gap may extend from fathers to sons.

What can children learn from playing with trains?

According to caregivers, trains can promote the skills under investigation—sharing/social skills, how to put things together/psychomotor skills, science and imaginary play (language was not mentioned). Responses regarding learning outcomes specifically related to the Train Table were somewhat more specific than those that referred to learning in the museum generally:

Social skills

Sharing

Social skills—waiting for their turn.

Psychomotor skills

Fine motor skills. Exercise.

Coordination.

Spatial awareness.

Science

Science—how the magnets repel or attract. Speed, velocity, inertia—how things move.

Polarity, mechanical thinking, coordination.

Magnets—attraction, repulsion. Trains go in a certain way dictated by the tracks.

About waves, curves, traffic.

Problem Solving

Problem solving—one of the cars doesn't fit under the ramp.

They are too small to reach the middle of the table: have to figure out how to go around.

Other

Imaginary play. He makes up different scenarios; makes up an imaginary world.

Interview Findings Specific to Ball Run

Almost half of the caregivers (45%) said that their child had played with the Ball Run before. Why did they think children liked playing with it? Selected responses:

"[He likes] the patterns and paths [the balls take], wondering where they are going to fall."

"[She plays with it] almost every time, loves the balls, the motion."

"It's dynamic and interactive."

When asked if it might remind their child of things s/he has done in other places, few respondents could think of anything similar other than playing with balls:

"A ball maze at home he sometimes plays with that is made more for a younger sibling."

"At preschool there is a dinosaur game that is similar."

"He also uses marble runs—he likes to see the consequences of his actions."

What can children learn from playing with the Ball Run?

When thinking about what children learn from the Ball Run, caregivers focused on a scientific world view—how to make meaning of phenomena—rather than specific social or psychomotor skills. These responses differed markedly from caregivers' ideas about what children learn from the Train Table. "Cause and effect" was the number one concept adults said that children could learn from the Ball Run. The other major conceptual outcome adults cited was making predictions and forming hypotheses. Several adults mentioned that children could learn about gravity from the Ball Run.

Cause and effect

Cause and effect. Variations. To see where [the balls] are going.

Where you drop it is where it goes.

Prediction, forming hypotheses

Makes them think about where the ball is going to.

Random bouncing; estimating where the ball comes out.

Gravity and motion

Movement, gravity, motion, cause and effect.

For him, he understands that when you drop things from a higher area they go down slower and from a lower area, they go faster.

Science

Basic principles of physics.

She made it an experiment.

Chance and variability.

II. Sustained Experience: Findings from Class

To compare our single-visit data with that of a more sustained experience dealing with themes related to trains and balls, the NYHOS organized a 1.5-hour pilot class in Preschool Place for 4-year-olds. Families were invited with the understanding that they attend all sessions and agree to participate in the research project. Five accepted—2 boys and 3 girls, with their significant adults: three mothers, one grandmother and a father.[3] Four children were frequent NYHOS visitors and one was visiting for the first time. All the families lived in Queens. Classes took place on Mondays, when the museum is closed to the public, on February 2, 9, 23 and March 9, 2009, from 11:00 to 12:30.

In preparation for this phase of the research, public programs staff and the evaluation consultant visited the Science and Nature Program for Young Children (SNP) at the American Museum of Natural History to learn about the structure and goals of its program. The SNP serves both tuition-paying and Head Start children and their parents. A basic tenet of the program is that young children learn best with a significant adult consistently present in their lives, hence SNP requires that a parent or close relative attend class with the child.

Class Structure

The class took place in the area of Preschool Place, where the Train Table and Ball Run are located. The first half hour of class was reserved for free exploration, with train- and ball-themed items placed strategically. During this period the researchers observed and interviewed the children and adults. At 11:30 the teacher, A, invited the children to have a snack and gather on the rug for organized activities. They sang a welcome song followed by hands-on experiments and art projects relating to trains and balls. There was a "movement" activity to get the children up and allow them to let off steam. The class ended with story time and a good-by song.

Week 1 introduced the concept "how do things move?" Week 2 covered circles, week 3 balls, bouncing and "gravity," and week 4 wrapped up with trains.

[3] The child's father attended only the first class with his daughter. She missed the second and came to the next 2 classes with a babysitter. His baseline interview suggests he was uncomfortable in class.

Participants

S, one month shy of 4 years old, speaks French with her mother, a homemaker. She bloomed during the movement activity, dancing around happily. S rarely responded to our questions until her mother repeated the question (in English). She has a younger sister and attends preschool.

Y, 4 years 4 months, is also shy. She has just returned from living abroad and the class is her first visit to the Hall. She attended the first class with her father, a graphic artist. She attends preschool.

B came with her grandmother, "Yaya," who cares for her while her mother attends school. She is 4½, with a bubbly personality, talkative from the outset. She has no siblings and attends preschool. Grandmother speaks strongly-accented English.

P, 4½, came with his mother, a psychologist, whom he clearly adores. He is very active, talkative and has a large vocabulary. He has an older brother and attends preschool.

N, 4 years and 3 months, is with his mother, a HS teacher on maternity leave. She dresses as a practicing Muslim. N has 2 older and 1 younger siblings and does not attend preschool.

Baseline Adult Information: Learning in Preschool Place

The baseline survey began by asking the caregivers whether they thought it more important for children to have fun or learn something in Preschool Place. Of course, it was a leading question, but we wanted parents to start thinking about the relationship of play and learning. Four of the adults said, "learn something" and one said "fun," adding, "Fun first. Learning is an added benefit." (S)[4] Other comments:

> At this age that's how they learn, through play. (P)
> She learns a lot [here]. (B)
> Education is fun. You can't take fun out of education. (N)

Questions from the general audience interviews asked the adults what they thought young children could learn in Preschool Place generally and from the target exhibits specifically.

Four of the adults gave multiple responses to the first question, stressing social and psychomotor skills.

[4] Letters in parentheses refer to the child the adult cared for, described above.

Social skills

Interacting with other kids, taking turns. (S)

Sharing, self-awareness. (P)

Psychomotor skills

She turns something, something happens. (B)

Sensory development, fine motor skills. (N)

He loves the vegetable area, touching and feeling. (N)

Language

Books, although we never sit down to read. (P)

Science

Motion. So far, physics-related stuff. (Y)

Food groups. (P)

Imaginative play

Miniature home environments (doll house), little puppet shows. (S)

We asked adults if their child had played with the Train Table or Ball Run during previous visits. The four children who had visited before had played with them. Reiterating a theme cited in the general audience responses, P's mother said, "It's a boy thing. They tend to go for action, things that move." The other boy's mother said that the Train Table was less interesting than the Ball Run: "Making things go around the track [is limited]—the ball drop is more entertaining: it shows cause and effect." B's grandmother said that B liked the Ball Run: "She likes throwing them down and seeing where they go."

Did either the Train or Ball Run remind the adults of anything their child does at home or elsewhere?

We have a train at home; she is mildly interested but not very. She seems more interested in it now [at home], like puzzles and how the [tracks] fit together. (S)

We have a train at home. P does more imaginative things than my older son, he's more artistic. (P)

Balls, she always plays with balls. Colors are important. (B)

He plays with blocks at home: sets them up and knocks them down to see what happens. (N)

What can children learn from the Train Table?

Motion. (Y)

Planning, organizational skills, sequencing, sharing. It's like city planning. (P)

What can children learn from the Ball Run?

Motion, physics. (Y)

Kids today have so many toys, short attention spans. The spinning is interesting. (S)

Cause and effect. (N)

Do the adults prefer to do things with their children in the museum or let them explore on their own?

Parents and extended family are young children's earliest and best teachers. However, findings from the general audience suggested that when bringing their children to the NYHOS, adults tended to sit back and let them work things out on their own. To delve deeper into this question, we asked the class parents what they preferred.

Y's father said "it depends": he would show his daughter how things work if it's not obvious, like the crank that lifts up the blocks. N's mother also said it depends: she has four children and the 14-month–old needs her almost-constant attention.

Three people said they like to let their children explore on her or his own:

> I usually come with my younger child. Sometimes I [play with S]. I try to get her to socialize with other kids. I don't want to box her in. Coming here is kind of a break for me. It's closed in and safe. It encourages more independence in play. (S)
>
> If he asks for help, I go. He likes the market area, role-playing. It depends on the maturity of the child. (P)
>
> It's more fun for them and they learn more [when they explore on their own]. (B)

Baseline interview with children

Interviewing the children proved unproductive (see Appendix 3 for transcript of Day 1 interviews). The children were shy with the interviewers, did not know what to expect on the first day of class, they could see their parents but were not close enough to ask them for answers. Overall they appeared not to understand what we expected of them. Our most useful information came from the adults who knew their children well and were happy to talk about them.

How do things move?

During the structured program, the instructor, A, had the children sit in a circle on the rug. She had gathered several balls and other objects and began a discussion about how they move. The two boys were the most outspoken: a rough tally of the number of times each child spoke, answering or asking a question, has P with more than 50 times, N with 35[5], Y with 10 and S and B with 4 each. The children tried out different ways to move the varying-size balls and balloons—rolling and bouncing—then blowing the balloons and feathers. P said the balloons and feathers were "floating."

A introduced an art project: drawing movement. The children became deeply engaged in the project, working with their respective adult caregivers. But they found it difficult to express movement graphically.

Y drew a 3-dimensional balloon with a face and a rolling ball collage (figure 10).

N drew balloons: "Helium balloon goes up in the air. I like helium balloons best." He drew several balloons with strings and happy faces. Then he drew Amir, his cousin. "I got him robot hands." "This is a balloon with legs." (Figure 11)

S explained (through her mother): "This is a balloon with air inside.

B drew a basketball with stripes and filled them in with multicolored markers. Then she drew a stick figure beside the ball and said that was she throwing the ball (figure 12).

P drew concentric circles and a baseball with red stitches (figure 13). He seemed to feel unable to depict movement, and began to shake and wave his paper to simulate movement.

A conducted a movement activity during which S became very animated. Y suggested they all get in a row and move like a train. P suggested they make themselves into balls and roll. A gave the children bells and tambourines to shake faster and faster, then slower and slower to illustrate movement at varying speeds.

[5] N was very reticent when a researcher tried to interview him during free play. He seemed to have been drawn out by the activities on the rug and the skill of the teacher.

Figure 10. Y's rolling ball collage

Figure 11. N draws Movement

Figure 12. B throwing a ball

Figure 13. P draws movement

Circles

During the second class, while the children engaged in free play, the researcher asked the adults if they could recall any anecdotes regarding something the children said or did that might reflect what they had learned in the class.

N told his father and aunt what he did; he talked about movement and balloons.

S talked about what they would do today on the way to class.

P, also on the way to class, talked about trains moving; he talked about the balls and feathers.

The children were more comfortable at the start of the second class. Familiarity with the class structure and participants helped them develop into a more socially cohesive group. At the Ball Run, a researcher asked P to predict where the ball would go: he traced a path on the glass with his finger. We talked about putting other size balls in the Run, but he worried that the hard plastic balls and marbles might break.

B practiced dexterity and counting. She gathered as many balls as she could—up to 6—and climbed on the block while holding them, to drop them down the Run. We counted how many she could hold at one time.

After free play, the instructor called the children to the rug and reminded them of the previous class activities involving movement. The second class focused on circles. Children named all the circles they could think of, many of them wheels on vehicles or types of spools. The day's experiment was observing objects traveling down a ramp to see how they moved—rolling or sliding, on their own or needing a push. Interestingly, instead of rolling spools down the ramp, the children stood them on their circular bases and slid them down. The ramp was raised and lowered to test what would happen with a more or less steep incline.

The art project involved rolling a paint-covered marble around in a box. The children were enthralled. They shared the colors and waited their turns patiently. They were developing small motor skills, moving the box so that the ball rolled to paint the entire paper (see S's painting below, figure 14).

Figure 14. S's rolling ball painting

Mid-term adult survey

Caregivers were our primary source of information on the class's more sustained impact on the children. We asked parents to rate the importance of each of the class activities on their child's learning. Unfortunately, only 3 adults responded to the survey—the adults with S, B and P—Y came with a babysitter who was unfamiliar with the class and activities, and N was absent. As table 4 illustrates, most adults thought all the activities were "very important," particularly free exploratory time and hands-on experiments. No one rated any activity "not so important." According to the adults, story time was the least important activity.

Table 4. Number of Caregivers Rating Class Activities

Class Activities	Very important	Kind of important	Not so important
Free exploration time in the classroom	3	-	-
Class meeting at the rug with group discussion	2	1	-
Hands-on experiments to explore the day's theme	3		-
Theme-related art projects	2	1	-
Movement activity	2	1	-
Story time	1	2	-

Adults' comments about the activities

"The activities appear to be well balanced. I especially like the hands-on approach." (S)

"I found it interesting." (B)

"I would move the movement activity to be conducted after the circle time. It just gives them an opportunity to get the wiggles out and keep the snack time as well." (P)

Main strengths of the program

"The variety of activities and explorations to explain one concept." (S)

"Organization and consistency. Patience of the class leader. Content of the material was appropriate for their age level. Participation of the kids." (P)

Potential weaknesses

"My daughter tends to complain in general about "non-princessy" items, but once she begins to play/explore in the class, she is fine. So I can't say for certain if she did not enjoy anything." (S)

"We enjoy coming here very much. My granddaughter enjoys learning with other children." (B)

"So far so good. The time is a little tough because of lunch." (P)

Benefits to intergenerational classes

"To see how your child cooperates in a class setting." (S)

"I was able to see her participation in a group." (B)

"A great opportunity to have fun with the kids and opportunities to learn. Gave me a chance to see how my child interacts with peers and adults on a social level (and in a group)." (P)

Drawbacks to intergenerational classes

"1) My daughter becomes more introverted if I am supervising her activities.

"2) Finding babysitting for my youngest daughter." (S)

"Not in this class with this group of parents. It seemed to be a nice balance between the independent activity of the child and their interactions with the group, and parents with some participation but not taking over the class." (P)

Effect on families' free time activities (books, TV, excursions)

"We try to offer a diversity of activities to our children so I am not sure how many are influenced by this class. Other than making frequent visits to this museum." (S)

Field trip

During circle time, the children talked about balls and circles in preparation for an excursion to the sports exhibition in the main museum. A museum educator took the children to a circular area (about 12 feet in diameter) composed of different types of flooring to illustrate how balls bounce differently on different surfaces, e.g., wood, sand, carpet. The children were excited and threw the balls around but did not appear to grasp the point of the activity. Perhaps there had not been adequate pre-visit preparation for understanding the notion that balls bounce differently on different types of surfaces.

Back in the classroom, an art activity was organized around balls, using cutout circles, markers and glue sticks.

P: "My ball is floating."

Y makes a rolling ball with swirling circles.

P draws a circle with bumps all around. His drawing quite accurately depicts a pink pimply ball.

B draws a bouncing ball (figure 15).

Figure 15. B's ball is bouncing.

Final class

P brought a ball-shaped robot to class, the kind that opens up when dropped on a hard surface. He dropped it in the Ball Run and it opened and would not roll down. P demonstrated his problem solving skills: he aimed and dropped the proper balls so that they hit the robot and nudged it forward. After numerous tries, he finally managed to bump his trapped robot down to the bottom of the Run so he could retrieve it. He was very excited about his success.

Then P put a train car in the Ball Run which also got stuck. He did not try to remove the car, but went off to play with something else. B came over to work on removing the train, using a modified version of P's strategy, dropping in multiple balls at once to knock the train further and further down the Ball Run, but did not succeed in fully removing the train. P then came back. B said to P, "Is the train coming out, P?" P then used B's multiple balls approach, which finally knocked the train out. P put a small doll in Ball Run and walked away (his mom removed it).

B told the researcher that one of the balls is new, a green and orange ball (which the researcher didn't remember seeing before either). When asked how she knew that, she shrugged.

Later, P played at the Train Table, moving the train in the air and into the water saying, "It's a helicopter train that can go on water," again revealing his imaginative nature.

Adult focus group

The researcher asked the adults to come to a corner of the room where they were in sight of the children who were working on an art project involving trains. A large group was visiting the Hall, making a great deal of noise and thereby limiting discussion.

Again we asked the adults if they had noticed anything that the children did or said at home that might be related to something they did in class.

B's grandmother reported that she was very interested in the ramp activity and had made her own ramp at home.

P's mother said that he rolled a ball at home the way they had done at the museum.

"N experimented with how fast things fell from his sister's upper bunk bed. He dropped feathers and balls and balloons and figured out which took the longest to fall."

"S suddenly started playing with the train set that she has had for a long time."

"N improved his verbal skills after several class programs." His mother believes the class affected his language development, helping him to become more open and more verbal. She added, "I've taken him to library programs, but he has grown more with this program after only a couple of times coming."

What do caregivers think the children learn here in the class? P's mother said, "Cause and effect." As for problem-solving skills, N's mother remarked, "One train was too big so he chucked it and played with the others." What about science, did the class activities promote science learning? P's mom thought they did: "Cause and effect and trial and error. In school so often they are not able to try things out. [Here they can explore] 'What happens if I do this?'" B's grandmother said B had learned new vocabulary, "Language [she is using language that might have come] from here, such as when B was playing with the ramp at home."

All the adults agreed that the class was a valuable program for their children.

"The activities are age appropriate, the language is appropriate. They get to move around. It gave P and I an opportunity to do something, just the two of us. Something he looks forward to." (P)

We asked the adults to suggest other topics that would be interesting to explore in class. S's mom suggested, "Food science, like food decomposition and smells and senses. S gets very excited about them."

What other programs did the children participate in?

B goes to a preschool 3 days a week. She is very interested in biology [the natural world].

N is in a library program and has arts and crafts once a week.

P is in school 3 days a week; he goes to Sunday school and art class and swimming.

Adults gave their opinions about the reasons children like the Train Table and Ball Run.

S's mom suggested: "It is like going into another world. It's like having an adventure."

P's mom: "It is soothing, too, the movement (makes sweeping gestures with her hands, like moving a train over the tracks). Something about it—it's just soothing."

The researcher explained the goals of an intergenerational class and asked what the group thought were the pros and cons of such a program.

Pro

"I've gotten ideas of how to re-direct P from watching A, like, 'Come over here and see this' [to distract him from being overactive]." (P)

"When parents and children are together I can observe him, which is good since he isn't in preschool." (N)

"We [can see] how they behave with the teacher and other children. Sometimes it looks like they aren't paying attention, but they say answers and I can tell she is paying attention." (B)

"I would love to learn more about his learning style. This really helped him open up, he is being more expressive. At home he is expressive, it's just outside he shuts down." (N)

Con

"Sometimes I want to jump in, but A (the teacher) does it better." (P)

"Sometimes the parents' presence makes them act up." (S)

Final Parent Survey

Four respondents completed the survey—S, P, N and Y's college-student-babysitter, who felt she could participate after attending 2 sessions. B's grandmother did not have her glasses but promised to send the survey back. It never arrived.

We reminded the adults of our goals of developing language, social and physical skills, and asked first how they thought the Train Table contributed to their child's learning. Social skills—sharing—again was an important learning outcome for the Train Table.

"Somewhat. I think it needs to have more things on it for children to explore." (N)

"[It helps them] share, talk to other children at the table, move around the table to move trains, make train sounds, attach trains to one another, take turns, [develop] patience, cooperation and it's fun for him. [He is learning the concept of horizontal movement, rolling wheels, over and under the bridges." (P)

"The train table is helpful to build kids' imaginations. Since it's a popular item, it helps kids learn to share. Kids also learn to navigate the trains better on the tracks." (S)

"In my viewpoint, the contribution of table training [Train Table] to a child's learning is very good for their language, social and physical skill development. While they are playing table train, they can meet people from different cultures, language and society. They have to play in a group, which develops sociable behavior in a child. [As for] physical development … they need to move around it which keeps them walking." (Y)

Thinking about the same goals—developing language, social and physical skills—how did the adults think the Ball Run contributes to their child's learning?

"The Ball Run is better [than the Train Table] because it allows N to observe cause and effect." (N)

"It offers many of the same examples as the Train Table, but less language is used because P tends to use it on his own and he enjoys this exhibit. Children can learn:
To share
To take turns
About gravity
Patience
About cause and effect
Move/climb up to get ball in to a hole to watch it go down
Concept of vertical movement, falling, sliding, rolling, etc." (P)

"It teaches kids about gravity, looking into different paths the balls can take. The outcomes always seem to thrill the kids as well." (S)

"I think ball drop doesn't only help children to develop socially and physically but also mentally. While playing ball drop what I have seen is that children are not just having fun but also learning something which helps them to prepare themselves for school. They are learning about the size, shapes and about hardness and softness while playing ball drop." (Y)

How much effect does each class activity have on children's language, social and physical skills?

Adults used a 5-point scale to rate each activity, from 5="very much" to 1="not at all."

Table 5. Ratings of the effect of free exploration time on skills

How much:	**Very much to a lot**	**Somewhat**	**A little to none at all**
Effect on Language development	2		2
Effect on Social skills	3	1	
Effect on Physical skills	4		

Table 6. Ratings of the effect of class meeting at the rug affect on skills

How much:	**Very much to a lot**	**Somewhat**	**A little to none at all**
Effect on Language development	4		
Effect on Social skills	4		
Effect on Physical skills	4		

Table 7. Ratings of the effect of art projects and investigations on skill

How much:	**Very much to a lot**	**Somewhat**	**A little to none at all**
Effect on Language development	2	1	1
Effect on Social skills	2	2	
Effect on Physical skills	4		

Table 8. Ratings of the effect of story time on skills

How much:	**Very much to a lot**	**Somewhat**	**A little to none at all**
Effect on Language development	4		
Effect on Social skills	2	2	
Effect on Physical skills	2	1	

Discussion

In 2000, the Bush administration launched the American Competitiveness Initiative, whose goal was to improve math and science education in the United States. Recent international comparisons rank America near the bottom of the list of developed nations in students' science achievement. The Academic Competitiveness Council (ACC) engaged in a year-long study to assess federal agency programs' success in science, technology, engineering and mathematics (STEM) and to identify areas for improvement for current and future programs (U.S. DOE, 2007).

There is widespread agreement among members of both the formal and informal education communities on the need for students to become science literate if they are to succeed in today's world, and there is general consensus that the earlier children are exposed to science, the more likely they are to achieve success. And yet few opportunities for the Nation's youngest children—preschoolers—address science. In addition, academic achievement for children progressing to more advanced levels in school, focuses on reading and math rather than science.

The American Association for the Advancement of Science's Project 2061 (AAAS, 1998) stresses the importance of early science education to support children's natural curiosity and drive to understand their world. It recommends methods that will allow children 6 years old and younger to retain the joy of discovery that leads to achievement in science, mathematics and technology when they reach school years. Last year, the National Research Council has produced a volume highlighting the value of informal science experiences to promote STEM achievement (AAS, 2008).

The NYHOS is ideally positioned to respond to the urgent need to attract young minds to STEM subjects. It has partnered with the New York City school system to supplement science programs through outreach and professional development. In recent years the rapid growth of the Hall's preschool audience has led to development of exhibits and programs targeted to this audience. The next generation of projects for this age group will benefit from research on how exhibits and programs with age-appropriate science content contribute to preschoolers' developing social, psychomotor and language skills.

Train Table and Ball Run

The most notable difference between the Train Table and the Ball Run's effect on children's development was the Ball Run's ability to draw caregivers into the activity along with their children. At the Ball Run, fewer parents sat in the back of the room or interacted only to enforce behavioral norms. We observed many parents in the general audience participating actively—helping or encouraging a child to reach an inaccessibly high opening, suggesting ideas for where and how to put the balls and initiating a game to see whose ball would arrive at the bottom first. Many caregivers were observed scaffolding their children's learning with reminders of other ball-related experiences, questions and asking children to predict or hypothesize "what do you think would happen if…."

Beaumont (2006) studied the interaction of mothers and their children aged 3-5 years. One of her secondary research questions was, what are the key elements of an exhibit that elicits strong parent-child interaction? Staff in one of the museums she studied had ideas for explaining the attraction of a certain exhibit (bubble making) for mothers: "Adults interact there because they have lots of ideas about what they can do there." "It is open-ended, lots of room for all…offering multiple opportunities for success, laughter and wonder." "It is intrinsically interesting to adults as well as children." Another exhibit, a water table, also elicited mother-child interaction. Staff at that museum suggested, "It's a good example of the ways in which parents can help direct the intended interactions … it's easy for a parent to see how they can contribute to their child's playing," and, "[The exhibit leads to] many different areas in cognitive development to explore, such as scientific thinking, which leads to many "why" questions." These explanations are relevant to the intergenerational attraction to the Ball Run as well.

Both the Train Table and Ball Run appear to attract more boys than girls (70% and 30%, 64% and 36% respectively) and boys remain there considerably longer. There are several possible explanations for this phenomenon: 1) both exhibit elements involve physically vigorous activity that may be more appealing to boys than girls—several parents remarked, "It's a boy thing;" 2) more families bring boys than girls to the science museum (possibly related to Kevin Crowley's finding that families tend to encourage boys more than girls at science exhibits, Crowley et al, 2001); 3) there were more families with boys during data collection sessions (unlikely because data collection took place over several weeks and on various days when families would be likely

to visit the Hall). Point number 2 above is beyond the scope of this study and requires analysis of the NYHOS audience demographics.

On the one hand, according to caregivers, both the Train Table and the Ball Run help children develop social skills and the norms of social intercourse: "excuse me," "may I play," "it's my turn," "I'm sorry," "please" and "thank you." But on the other hand, the Train Table seems to inspire more aggressive behaviors, while the Ball Run encourages more cooperative ones. Perhaps the participation of more adults at the Ball Run keeps behavior in check. A stereotypical explanation would be gender based: boys tend to be more aggressive and girls more passive.

Both exhibit components had positive effects on children's psychomotor skills. They encourage small and large muscle development and require children to use problem-solving skills to navigate some of the hurdles, such as a too-tall locomotive on the Train Table and inaccessible openings in the Ball Run.

Caregivers indicate that the Train Table and Ball Run have less effect on children's language acquisition, the study's third developmental objective. Parents in the general audience did not mention this as something their children could learn in the Hall or at one of the two exhibits. However, parents whose children attended the pilot class did cite language development as something they noticed and attributed to the museum experience. This suggests that while a casual visit can impact social and psychomotor development, it requires a more sustained museum experience to affect all three areas of development.

Children's long attention span at the Train Table and Ball Run may be partially explained by familiarity with Preschool Place: 2 in 3 families in the general audience and 4 in 5 families in the class seemed to visit the Hall frequently. Familiarity would allow children to focus on what they liked since they had already explored all the options during previous visits. Parents in Beaumont's study (2006) attributed extended attention spans to growth and maturity, which may also be a factor in the NYHOS sample. One of Beaumont's mothers said, "Instead of spending 2 minutes here and 2 minutes there…she actually [spends] 15 or 20 minutes and that would have never happened before."

Caregivers in both the general audience and the class samples hoped and believed that their children learned science during a visit to the NYHOS. Both groups mentioned "cause and effect" as something the children could learn there. Again, the class experience led caregivers to cite

more general themes, such as hypothesis forming, testing by trial and error and problem-solving as outcomes of the more sustained experience.

Adults told us that boys and girls can glean several science-related concepts from the exhibits:

- Magnetism: children from 2½ to 5 seemed to grasp intuitively how to make the train cars stick together. Also, they seemed to understand polarity—a car that was not sticking to the next one would attach if they turned it. Although they might be familiar with magnets, they did not transfer this knowledge to the "force" that held the train cars together. When asked how the cars stuck together, a 4-year-old boy who had used magnets and talked about how they only stick to metal could not say why the trains stuck together. This kind of inferential process could be encouraged by a more sustained experience that scaffolds what a child knows about magnets to a new experience with magnetism that looks unfamiliar at first.
- Gravity: the Ball Run seems to lead children to experiment with dropping items. The more sustained experience actually showed that children were taking the ideas home and continuing to try out different hypotheses.
- Cause and effect expands on one of the very first things children learn: that they can affect their surroundings in various ways. Parents believed that children could learn more scientific aspects of cause and effect in the Hall; they cited the Ball Run in this context more frequently than the Train Table.

Many parents said their children had a train at home, but it was not always set up or used on a daily basis. On the other hand, none of the parents said their child had anything resembling a ball run—balls, yes, and perhaps a marble run at home or at school. But the Ball Run at NYHOS represents a novel experience, novelty with familiar items—balls and moving parts. All three of these attributes—familiarity, novelty and moving parts—are powerful attractions for children. The Ball Run could increase its impact by adding supplementary items. Different size balls or balls of varying density and shape might add to the novelty as well as the learning potential.

One of the class parents found the Train Table less constructive in terms of learning; she suggested adding more items to inspire imaginative play. There were traces on the site of previously existing structures, but the only auxiliary items currently in use are the garage with its

mysterious buttons and a stop/go sign in need of repair. Obviously the NYHOS visitors' impact on equipment is many orders of magnitude greater than in someone's home; still it is worth including items that might need to be replaced from time to time to encourage train-related imaginative play. A station, a loading platform, a car transport vehicle, etc. would add value to the Train Table and might encourage more social interaction among children.

Researchers have noted the importance of unstructured exploration time to observe, develop theories and test them (Benson and Leeper Miller, 2008). Preschool Place activities support this notion both in general public visits and planned programs. The Preschool Place environment supports social interaction where children who seem to be playing in parallel alongside each other, yet are observing and learning from each other—imitating a way of reaching a higher opening in the Ball Run or figuring out how to let the train slide downhill on its own.

Sustained Learning Experiences

The pilot class program was modeled roughly on the Science & Nature Program for Young Children (SNP) at the American Museum of Natural History. Research psychologist Edward Chittenden defines the SNP's basic premise: "Children attain deeper and more sustained learning when significant adults in their lives are engaged in the process" (2003, p.1). To supplement our in-class observations and interviews, we adapted Chittenden's method of interviewing parents about the "ways children—at home or elsewhere—build upon the experiences they have had in the [museum]." Chittenden adds, "Children's classroom comments, drawings and projects generally indicate what they find engaging and meaningful in the program. But evidence of what they 'take away' from their museum experiences, in a more lasting sense, is more difficult to come by."

Parent interviews provided valuable information about sustained learning because they not only observed their children at home, but unlike typical preschool programs, they participated in the class experience. Following the lead of Chittenden et al (2004), we asked caregivers to report things children may have said or done at home that related to what happened in class. N's mother reported his experiments dropping objects of different sizes and weights from the top of his sister's bunk bed. B's grandmother reported B's experiments building ramps at home, repeating the class activity. This evidence indicates that children in a sustained program use their developing psychomotor and language skills beyond the museum setting.

Other researchers documenting the value of parental mediation in children's science learning (Crowley and Jacobs, 2002, Crowley et al, 2001) suggest that parents shape children's scientific thinking in everyday activities. They note that when children engage with an exhibit with their parents, they spend more time and delve deeper into questions and explanations. Parents also can perform the important role of linking novel events to the child's prior experiences. We observed parents mediating experiences among the general audience at the Ball Run, and we heard class parents describe how children continued a class experiment at home. Our research in Preschool Place underscores the crucial role parents play in skills development and early science learning.

Parent interviews underscored the notion that multisession experiences have impact that goes beyond the single visit experience. The variety of ball-related activities in class—rolling and sliding objects down ramps, studying the movement of various items—supplemented the Ball Run activity itself. Class activities plus keen observation of the path the balls took through the run as they bounced down ramps and through flappers led a boy to solve an engineering problem—how to remove a toy that was stuck in the apparatus. He figured out how use balls to nudge the toy forward, repeating the steps many times until it finally fell to the bottom. In this example of psychomotor development, the child recognized a problem, used observation of phenomena to form a theory, tested it and achieved reinforcement from success. Later, another child who had observed the first, tried to replicate the experiment to extricate another toy.

Parents enjoyed the opportunity of seeing their children participating in a group, rarely available in a preschool setting. The adults could observe their child's developing social interactions as well as their learning styles. One of the class parents appreciated having an experience to share with her son, just the two of them. In addition to the role of observer of their child's learning, parents who share learning experiences can become mediators of their child's informal science learning by extending the experiences into the home. Interestingly, parents did not seem to be drawn to the experience of being a co-learner with their children as much during casual visits as they did during the more structured class sessions.

This project confirmed the difficulty inherent in attempting to interview preschool children. It soon became clear that this was not the best way of collecting information. Certainly the children were timid when confronted by strangers—the infrequency of the pilot class made it difficult for the interviewers to develop a sustained relationship with them. The children did bond with each

other and with the teacher, to a certain extent. Furthermore, the 5 intelligent children in the class probably thought our questions were stupid (What are you doing? Can you tell me what happened?). They may have thought we were trying to trick them because it was obvious what they were doing—playing with train or balls. Some questions were probably too abstract for 4-year-olds (What's the best thing about playing with trains?) We noted that the children had large vocabularies and appeared to understand more than they could or were willing to verbalize. A more successful format for interviewing children would have fewer distractions. In the future, interviews could be conducted with parent-child dyads, using visual cues such as sorting activities to elicit children's verbal responses.

Standards

The American Association for the Advancement of Science (AAAS) promotes science literacy and since 1993 has been publishing guidelines to reach the goal of Science for All Americans. To that end, AAAS published *Benchmarks* for science literacy, standardizing what K-12 students should know at certain points. Our Preschool Place target audience was younger than kindergarten age, but researchers such as Chittenden are finding that children as young as 3 years old are capable of developing a "scientific worldview" based on their natural curiosity about how their world works and rudimentary methods of scientific inquiry, such as observation, hypothesis formation and experimentation. These are the basic building blocks of what *Benchmarks* calls "The Nature of Science" in its chapter 1 (*Benchmarks On-line,* 1993, 2009).

Exhibits such as the Train Table and Ball Run in Preschool Place and other informal learning environments support the AAAS *Atlas of Science Literacy* benchmarks for K-12 students, specifically:

- Habits of mind: ability to count using whole numbers, estimate and measure;
- Nature of science and scientific inquiry: evidence and reasoning; raise questions about the world around them and look for answers by making observations and trying things out; describe and compare things based on numbers, shape, texture, size, color and motion;
- The physical setting: shapes such as circles, squares and triangles are used to describe things; things fall to the ground unless something holds them up (gravity); the way to change how something is moving is to give it a push or a pull (laws of motion);
- Models: some toys look like the real thing but are different in size and other attributes;

The most recent AAAS publication is particularly relevant for this research: *Learning Science in Informal Environments: People, Places and Pursuits* (2008). The document proposes six "strands of science learning" for science education in informal settings.

1. Experience excitement, interest and motivation to learn about phenomena in the natural and physical world;
2. Come to generate, understand, remember and use concepts, explanations, arguments, models and facts related to science;
3. Manipulate, test, explore, predict, question, observe and make sense of the natural and physical world;
4. Reflect on science as a way of knowing; on processes, concepts and institutions of science; and on their own process of learning about phenomena;
5. Participate in scientific activities and learning practices with others, using scientific language and tools;
6. Think about themselves as science learners and develop an identity as someone who knows about, uses and sometimes contributes to science.

Some of these are of course distant goals, not achievable in the preschool years. Others, such as numbers 1 and 3, are definitely observable in our preschool subjects. All of them support the objectives of developing social, language and psychomotor skills.

The AAAS Project 2061 forum and the published papers from participants concluded that we now know that children are capable of more than we had previously thought (Johnson, 1998). As Karen Lind noted, "Science is understood to be a process of finding out and a system for organizing and reporting discoveries. Rather than being viewed as the memorization of facts, science is seen as a way of thinking and trying to understand the world" (AAAS, 1999), thus it fits perfectly into what preschoolers do naturally. Children and their caregivers see the exhibits at the NYHOS as an enjoyable family outing, not as threatening science lessons.

The Hall encourages exactly what AAAS recommends in *Learning Science in Informal Environments*: "adult caregivers play a critical role in supporting science learning." A number of researchers cite the importance of mentoring and scaffolding children's learning by building on their prior knowledge. The Ball Run was particularly effective in this area because caregivers entered into the activity with their children, encouraging experimentation and prediction.

Conclusions and Recommendations

This study suggests that Preschool Place exhibits have positive impact on children's social and psychomotor skills development, but that they have limited effect on the development of language skills. The Hall might consider adding labels to some of the exhibits. Although most of the target visitors will not be able to read them, parents can use them to spark discussion, thereby helping with language and vocabulary development. Words such as "conveyor belt," "environment," "transportation," "experiment" and more, refer to items that interest adults and children. Labels such as "Train" and "Ball Run" could help children develop sight words and reading readiness.

The study reaffirms the value of parents (or significant adults) as mediators in children's development of social, psychomotor and language skills as well as early science concepts. It also highlights the value of parents as informants for the study of early childhood learning. First, preschool children are unreliable and uncommunicative interview subjects. And second, parents familiar with both the museum and home experiences, unavailable to researchers, can testify to how these experiences overlap and influence each other.

The pilot class developed for this research project suggests that a sustained preschool science experience is effective. Children enjoyed it and their parents appreciated observing their children's developing social, physical and language skills. Parents could see development over time even after just the four classes in the session. When prompted, they could identify longer-term learning outcomes as well. Parents said they would participate in a similar program if offered. The NYHOS should investigate the possibility of providing a sustained preschool science program.

Children may not know they are doing science—they are doing what they do naturally: observing, experimenting and forming theories about the way their world works. Researchers believe that early experiences with science could result in children's maintaining their interest and pursuing science achievement as they move into formal schooling.

NYHOS might consider training Explainers to help parents scaffold their children's learning by connecting their prior experiences with new information and experiences. While Explainers model this inquiry method consistently, a more focused approach might help parents understand

more fully that they are their children's earliest science educators. In addition, it would add a valuable dimension to Explainers' training.

Caregiver interviews (from the class) indicated that parents are interested in learning more about how their children learn—their learning styles. An intergenerational class program might offer parents time to discuss this aspect of parenting with a facilitator. Most adult caregivers could benefit from "learning theory lite," particularly as it relates to early science. Early science just might "look like" what families do every day—measuring to prepare food, measuring and weighing each other, playing ball, using bicycles and other vehicles, turning on the light—anything that a child could ask "How?" or "Why?" about.

Museum exhibits receive extraordinary use and punishment. The fact that they wear down is a sign of children's intense interest in them. The heavy use and rough handling the exhibit receives is a challenge, but maintenance of popular exhibits is a necessary aspect of children's programming. The Train Table needs attention; a variety of structures should be replaced or added to encourage imaginative play.

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Appendix 1. Demographic Data

Missing data was the result of data collectors failure to note it.

Train Table Observations

Table 9. Gender: Children

Children	Percent	Number
Male	66%	29
Female	34%	15
Total	100%	44

Table 10. Gender: Adults

Caregivers	Percent	Number
Male	36%	15
Female	64%	27
Total	100%	42

Table 11. Age: Children

Age	Percent	Number
Up to 3 years	33%	15
>3 to 4 years	51%	23
>4 years	16%	7
	100%	45

Train Tab le Interviews

Table 12. Gender: Children (N=38)

Children	Percent	Number
Male	71%	27
Female	29%	11
Total	100%	38

Table 13. Gender: Adult Caregivers (N=38)

Adults	Percent	Number
Male	42%	16
Female	58%	22
Total	100%	38

Table 14. Adult Caregivers' Relationship to Child (N=38)

Relationship	Percent	Number
Mother	58%	22
Father	34%	13
Grandfather	5%	2
Grandmother	3%	1
Total		38

Table 15. Respondents' Residence

Location	Percent	Number
Queens	60%	21
Brooklyn	14%	5
Manhattan	11%	4
Long Island	11%	4
Bronx	3%	1
Staten Island	-	-
New Jersey	-	-
Other	-	-
Total	100%	35
Missing Data		3

Ball Run Observations and Interviews

Table 16. Gender: Children (N=44)

Children	Percent	Number
Male	57%	20
Female	43%	15
Total	100%	35
Missing Data		9

Table 17. Age: Children (N=36)

Age	Percent	Number
Up to 3 years	43%	15
>3 to 4 years	40%	14
>4 years	17%	6
Total	100%	35
Missing Data		1

Table 18. Gender Adult Caregivers (N=36)

Adults	Percent	Number
Male	30%	9
Female	70%	21
Total	100%	30
Missing Data		6

Table 18. Adult Caregivers' Relationship to Child (N=36)

Relationship	Percent	Number
Mother	63%	19
Father	33%	10
Grandmother	3%	1
Total	100%	30
Missing Data		6

Table 19. Respondents' Residence (N=36)

Location	Percent	Number
Queens	63%	19
Brooklyn	17%	5
Long Island	13%	4
Manhattan	7%	2
Bronx	-	-
Staten Island	-	-
New Jersey	-	-
Other	-	-
Total	100%	30
Missing Data		6

Appendix 2. Instruments

General Audience: Train Table

Language (check and specify)

1		**Talks during play:**
1.1		Uses vocabulary related to trains
1.2		…vocabulary related to motion
1.3		…vocabulary related to environment on table top
2		**Other sounds:**
2.1		Train-related sounds
2.2		Exclamations: (e.g., "wow", oooh, look!)
2.3		Angry, crying (due to conflict, frustration)
3		**Verbal communication with other children**
3.1		Positive, cooperative, negotiations or directions
3.2		Negative, "mine", not sharing
4		Verbal communication with adults (parent or staff)

Social (check and describe interaction)

5		**Plays alone**
6		**Interacts with other children:**
6.1		Negative (Conflict/grabbing trains, refusing to share, etc)
6.2		Cooperative play with children (e.g., helping, sharing)
6.3		Other:
7		Cooperative play with adults (e.g., building steps to reach higher, collecting balls)

Psychomotor (check describe interaction)

8		**Plays with trains in tracks**
8.1		Moves connected cars along track w/one hand
8.2		Moves connected cars along track w/two hands
8.3		Full loop on tracks (moves around table)
8.4		Lets train go downhill without holding
8.5		Parks train(s) in garage
8.6		Plays with other items on train table
9		**Connects train cars together by their magnets**
9.1		Repeats connection when they detach
9.2		Understands polarity (turns cars around so magnets attract) __Yes __No
10		**Copes with underpass when trains don't fit under**:
10.1		Backs up
10.2		Jumps trains that don't fit over
11		**Inappropriate use:**
11.1		Plays with train off tracks
11.2		Plays with train off train-table
11.3		Removes trains
11.4		Other:
12		**Goes to another train table**

13. Other:

14. Total Time at Train table: _____ 15. Age___ 16. gender of child: _____

17. Agrees to interview? __Yes __No

Parent Interview

The Hall of Science wants to learn about young children's learning in this space. I'd like to ask you a few questions about your child's experience here. It will only take a few minutes and we can stay close to the child.

1. What is your relationship to the child you are caring for? (include gender, e.g., uncle, sitter F) _____

2. Is this your first visit to the NYHoS/Preschool Place? ☐ Yes ☐ No.

2a. *If no*, how many times this year? ☐ 1 or 2, ☐ 3 – 6, ☐ 1 x per month, ☐ 2 x per month, ☐ 1 per week or more

3. What is the main reason you bring your child (*grandchild, nephew, etc*.) here?

4. What do you think young children are learning in this space? (*do <u>not</u> read list; check and/or describe*)

☐ Language skills

☐ Social skills

☐ Psychomotor skills

☐ Science

☐ Other (specify)

5. (*If not first visit*) Has your child played with this before when you were here? __No __Yes:

5a. *If yes*, why do you think s/he likes it?

6. Does it remind you of anything he does at home or other places?

7. What do you think children learn from this activity?

8 As you watched your child playing with the trains, what were you thinking about?

General Audience: Ball Run

Language (check and specify)

1		**Talks during play:**
1.1		Uses vocabulary related to balls
1.2		…other relevant vocabulary (holes, bouncing, falling, dropping, etc)
1.3		Other:
2		**Other sounds:**
2.1		Exclamation at outcome (including "wow" or "look")
2.2		Angry, crying (conflict with other children, frustrated)
3		**Verbal communication with other children**:
3.1		Positive, cooperative, negotiations or directions
3.2		Negative, "mine", not sharing
4		Verbal communication with adults (parent or staff)

Social (check and describe interaction)

5		**Plays alone:**
6		**Interacts with other children:**
6.1		Negative (Conflict/grabbing balls, refusing to share, etc)
6.2		Cooperative play with children (e.g., building steps to reach higher, collecting balls)
6.3		Other:
7		Cooperative play with adults (e.g., building steps to reach higher, collecting balls)

Psychomotor (check describe interaction)

8		**Drops ball in accessible hole**
8.1		Drops ball in same hole repeatedly
8.2		Drops ball in different holes, different places
9		**Attempts to reach inaccessible hole**
9.1		Uses an aid to reach previously inaccessible hole (block, adult help)
10		**Picks up one ball at a time**
11		**Picks up several balls at once**
11.1		Placing more than one ball at once in same hole
11.2		Placing more than one ball at once in different holes
12		**Guesses where to wait at bottom**
13		**Uses ball run inappropriately:**
13.1		Places non-ball object in hole
13.2		Removes balls from activity
13.3		Uses ball in non-ball run exhibit or on floor

14. Other/comments:

15. Total Time at Ball run: _____ **16. Age:_____** **17. gender of child: _____**

18. Agrees to interview? __Yes __No

Parent Interview

The Hall of Science wants to learn about young children's learning in this space. I'd like to ask you a few questions about your child's experience here. It will only take a few minutes and we can stay close to the child.

1. What is your relationship to the child you are caring for? (include gender, e.g., uncle, sitter F) _____

2. Is this your first visit to the NYHoS/Preschool Place? ☐ Yes ☐ No.

2a. *If no*, how many times this year? ☐ 1 or 2, ☐ 3 – 6, ☐ 1 x per month, ☐ 2 x per month, ☐ 1 per week or more

3. What is the main reason you bring your child (*grandchild, nephew, etc*.) here?

4. What do you think young children are learning in this space? (*do <u>not</u> read list; check and/or describe*)

☐ Language skills

☐ Social skills

☐ Psychomotor skills

☐ Science

☐ Other (specify)

5. (*If not first visit*) Has your child played with this before when you were here? __No __Yes:

5a. *If yes*, why do you think s/he likes it?

6. Does it remind you of anything he does at home or other places?

7. What do you think children learn from this activity?

8 As you watched your child playing, what were you thinking about?

Class: Child Interview 1

The more open ended the better. We just want to generate descriptive dialog and gestures from them, with a focus on vocabulary, so we can somehow quantify them and then weigh them at the end of the class.

What are you doing? Can you tell me about it?

*Prompts for trains—**do not lead**: Anything else? If cars become uncoupled: what makes them stick together? If attempts to attach cars fail due to polarity: Why didn't those 2 cars stick together? Does this remind you of something you do in your daily life (at home or somewhere else?)*

*Prompts for ball drop—**do not lead**: Why are you moving the block over? If s/he says to reach higher: why do you want to do that? If anticipates where ball will end up: how do you know where the ball will land? Does this remind you of something you do in your daily life (at home or somewhere else?)*

Do you like to play with [train/balls] by yourself or with others? Parent? Other child? Why?

The best thing about the train table is…/The best thing about the ball drop is…

Class: Adult Interview 1

The Hall of Science wants to learn about young children's learning in this space. I'd like to ask you a few questions about your child's experience here. It's just your opinions; there are no right or wrong answers.

1. What is your relationship to [child]? (include gender, e.g., uncle, sitter F) _____

2. Is this your first visit to the NYHoS/Preschool Place? ☐ Yes ☐ No.

2a. *If no*, how many times this year? ☐ 1 or 2, ☐ 3 – 6, ☐ 1 x per month, ☐ 2 x per month, ☐ 1 per week or more

3. When kids come to this part of the museum, do you think it is more important for them to have fun or learn something?

__Fun __Learn __Both

3a. Could you tell me more about that? Why is that important?

4. What kinds of things do you think young children are learning in this space? (*do <u>not</u> read list; check and/or describe*)

☐ Language skills

☐ Social skills

☐ Psychomotor skills

☐ Science

☐ Other (specify)

5. (*If not first visit*) Has your child played with the train or ball drop before when you were here? __No __Yes:

5a. *If yes*, why do you think s/he likes it?

6. Does it remind you of anything he does at home or other places?

7. What do you think children learn from those particular activities [train table or ball drop]?

8. In general, when you come to a place like this, do you like to do things with your child or let her/him explore on his/her own? __together __on own __depends/both Why is that?

Adult Discussion Guide

Parent discussion

Language, social skills, physical skills

Train table:

- any discussions of trains, wheels, movement outside class?
- magnetism
- Tracks?
- Trains at home?
- Related books, TV at home

Ball drop

- Any discussion at home
- gravity?
- Different types of balls
- Games, books, sports, tv at home

Problem solving strategies

- Big train and underpasses
- Make long train and keep cars attached
- How to get balls in top hole
- many balls at once

Do these activities relate to science? How?

Midterm survey

1. Class activities are usually organized around the following. Please rate the importance of each for your child's learning about science and nature.

	Very important	Kind of important	Not so important
Free exploration time in the classroom			
Class meeting at the rug with group discussion			
Hands-on experiments to explore the day's theme			
Theme related art projects			
Movement activity			
Story time			

Your comments about the class activities:

2. What do you think are the main strengths of the program?

3. Was there anything that you or your child did not particularly enjoy or find interesting?

4. As you know, a parent or other family member must attend each class with their child.

a. What do you see as the benefits to this requirement?

b. Are there any drawbacks to this requirement? If so, what are they?

5. Have NYHOS classes influenced your family's choice of free time activities (for example, books, TV programs, videos, family excursions)? Please explain:

Parent's name: Child's name: Age:

Final Survey

Dear Parents and Grandparents,

The last class has come so soon! Unfortunately, I was out sick for one class and we had a snow day for another. As you know, the class was designed as a pilot project for two purposes.

- First, we have a grant to study how young children learn in a science museum setting. The museum elected to focus on two popular exhibit elements—the train table and ball drop—to see how they contribute to social and language development and increased physical dexterity.
- Second, we are assessing the possibility of offering a similar program for intergenerational science learning in the future.

As a parent or grandparent, your experiences will help us with our research agenda and also help shape future classes. Please take a few moments to answer questions pertaining to the past few weeks. We have enjoyed having you and your child as participants in the program.

Thank you,

Alice Stevenson, Senior Manager of Family Programs and Preschool Learning
Ellen Giusti, Project Evaluator (egiusti@nyc.rr.com)

Parent's name: Email:

Child's name: Age: Does your child attend preschool?

1. Keeping in mind our goals of developing language, social and physical skills, how do you think the train table contributes to your child's learning?

2. Thinking about the same goals—developing language, social and physical skills—how do you think the ball drop contributes to your child's learning?

3. How much effect does each class activity have on your child's developing language, social and physical skills? Please use a 5 point scale to rate them, from 5="very much" to 1="not at all."

Please rate the effect of <u>free exploration time</u> on skills? Check one box below.

How much:	**Very much 5**	**4**	**Somewhat 3**	**2**	**None at all 1**
Effect on Language development					
Effect on Social skills					
Effect on Physical skills					

Please rate the effect of <u>class meeting at the rug</u> affect on skills? Check one box below.

How much:	**Very much 5**	**4**	**Somewhat 3**	**2**	**None at all 1**
Effect on Language development					
Effect on Social skills					
Effect on Physical skills					

Please rate the effect of <u>art projects and investigations</u> on skills? Check one box below.

How much:	**Very much 5**	**4**	**Somewhat 3**	**2**	**None at all 1**
Effect on Language development					
Effect on Social skills					
Effect on Physical skills					

Please rate the effect of <u>story time</u> on skills. Check one box below.

How much:	**Very much 5**	**4**	**Somewhat 3**	**2**	**None at all 1**
Effect on Language development					
Effect on Social skills					
Effect on Physical skills					

Preschool Place Class

We are interested in how children may apply what they learn in here to other situations. As an observer of your child's learning, could you please provide us with a few specific examples of something your child did or said (at home, in the park, etc.) that may reflect experiences in this mini-class?

We appreciate your help!

Appendix 3. Class Children Observation & Interview Results, Day 1

S

During free play, S did not play with the Train Table or the Ball Run. During the activities on the rug, she was very shy, contributing few responses. During the physical movement activities, S became engaged in moving her body and shaking the bells. After the activities, she played for a few minutes with the Ball Run. She was shy about responding to the researchers' questions and several times ignored the questions in favor of pointing and showing what she was doing. At one point her mother re-asked a question and still she did not respond.

B

B was verbally and physically outgoing during the free playtime, both in play and conversation. She played with both the Train Table and the Ball Run. When Y came over to the Ball Run, B unprompted shares her balls. They play together at the ball run and sit together on the carpet. During the structured portion of the class, she contributed few responses and stayed on the edge of the rug when other kids were moving to the middle to look at balls or the book that was read.

Y

Y was there with her dad. They had explored many different areas before Y came over to the Ball Run area. When she was there, B was there too and shared her balls with Y. During the structured period, she sat next to B and was fairly quiet.

P

P was very outgoing with his play at the Train Table and in conversation. During the structured activities, he contributed far more comments than most of the other children and his interview was much more informative. His comment about pretending the trains were boats reflects his mother's description of his play behavior. He said that the best thing about playing with trains is "the trains," and demonstrated how he makes them move around the track quickly. He confirmed his gregarious nature by saying he likes to play with other people rather than by himself.

P said he did not know what made the trains stick together. Later he was playing with magnets and demonstrated that he knew the word "magnet" and how they behave. He knew that magnets stick only to metal ("It won't stick to that because it's plastic." E: What will it stick to? P: "Metal"). But he did not transfer the concept to the trains. This occurred several times among children in the general audience.

Part 2

S

K: I saw you moved that block—what are you going to do with the block?

K: Where do you think the ball will end up?

K: What is the best thing about playing with the ball drop?

K: What are you doing with the balls?

S responds: There and there and there and go over here.

K: Do you like to play with the balls by yourself or with someone else?

S: Both

K: Which do you like better? Which is your favorite? S: Shrugs

B

K: Can you tell me what just happened? (train fell off the tracks after she ran it very fast)

B: It fell down. (B is reconnecting the cars)

K: How do they stick together?

B: I don't know

K: Do you like to play with the trains by yourself or with other people?

B: With other kids.

K: Why's that?

B: I don't know.

B goes over to the Ball Run, moving a block from the stack in front.

K: Why did you move that block over here? (no response, moves another block over)

K: What's going on?

B: They're all falling (the balls).

K: Where is it going?

B: That one's kinda weird.

K: What is the best thing about playing with the ball run?

B: I don't know

Y

K: What's going on here (Ball Run)?

Y: Watch mine.

K: What are you going to try next?

Y: I'm gonna show you.

K: What's happening?

Y: Some fell over the side.

K: Does this remind you of anything you play with at home?

Y: I don't have one of these at home.

K: Do you play with balls at home?

Y asks her dad if she has balls at home. He responds that she has a soccer ball at home. She tells me she has a soccer ball.

K: Do you like playing with this with other people or by yourself?

Y: Both

Y: I'm gonna try to get it in there (throws ball aiming to where she points)

P

K: What are you doing here? (shows me what he is doing with the train without verbalizing)

K: (While he is attaching the trains) What makes the trains stick together?

P: I don't know.

K: What are you doing with the trains now? (The trains are in the water portion of the table)

P: I'm pretending they are boats.

K: Do you like to play with the trains by yourself or with other people?

P: Other people

K: Why do you like playing at the train table with other people?

P: I just do.

K: What is the best thing about playing with the train table?

P: The trains

K: What about the trains?

P: I like making the trains go like this: choo-choo-choo. (moves the train very quickly around the table while making the choo-choo sounds).