EXPLORING HOW CHILDREN USE SCIENCE PROCESS SKILLS IN A MUSEUM SETTING

by

Lisa Marie Lundgren

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Lisa Marie Lundgren

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ABSTRACT

The Florida Museum of Natural History is constructing a new and improved Discovery Room for children. The use of science process skills such as observation, communication, measurement, classification, inference, and prediction had not been studied. In order to ensure scientifically appropriate stations in the new exhibit, research into how children use these skills was conducted in the existing Discovery Room. Children were observed and timed during their visit. Guardians of the children were interviewed or surveyed after the visit was completed. Analysis indicated that dynamic stations, such as the Wind Tunnel, enticed children more than static stations, like a wall-sized Memory Game. In order to ensure success in the Discovery Room that will be constructed in 2015, the Discovery Room should feature dynamic stations that engage science process skills such as prediction and inference.

INTRODUCTION AND BACKGROUND

Project Background

In the Florida Museum of Natural History's Discovery Room, I conducted research to find out if children interact with the exhibit in scientifically meaningful ways. This exhibit is designed for younger audiences—infants through elementary school-aged children. My action research project aimed to study the phenomena of children interacting with the Discovery Room as well as to understand what contributed to greater holding time in the Discovery Room. Holding time in an exhibit refers to the amount of time a visitor will remain engaged in the exhibit (Gutwill and Allen, 2009).

The Florida Museum of Natural History (FLMNH) is located in Gainesville, Florida. The museum is incorporated with the University of Florida and therefore the museum conducts cutting-edge research on diverse subjects such as butterfly morphology, Florida fossils, and archaeological studies about Florida's past inhabitants. FLMNH's mission is "understanding, preserving and interpreting biological diversity and cultural heritage to ensure their survival for future generations" (Fazenbaker, n.d.). The museum houses four permanent exhibit galleries and two changing exhibit galleries, plus a small exhibit space called the Discovery Room devoted to younger visitors. General admission to the three of the four permanent exhibits is free, while admission is charged for the changing exhibits and the Butterfly Rainforest. From 2012 to 2013, 191,227 people visited the Florida Museum of Natural History (Ramey, 2013). These visitors came from all over Florida and the United States. FLMNH is heavily invested in its volunteer program, with hundreds of volunteers caring for butteries and plants, conducting research, and giving guided tours to school children from the surrounding area.

Museum membership peaked this year at 1,113 members, or about one percent of Gainesville's population (Ramey, 2013). Gainesville is a fairly diverse community of 127,488 individuals. In 2013, the U.S. Census Bureau reported that 64.9 percent of the population was white, 23 percent was Black or African American, and ten percent were Hispanic or Latino (U.S. Census Bureau, 2014). The Florida Museum of Natural History receives higher than average visitorship of whites and Asians in regard to the population of Gainesville. For further demographics of the Florida Museum of Natural History, see Figure 8 in the Data and Analysis section of this paper.

Within the Florida Museum of Natural History is the Discovery Room where I conducted my research. The room consists of different stations that visitors can explore. In order to understand the interactions more fully, Table 1 lists the stations followed by descriptions of the stations.

Table 1
Discovery Room Stations

1. Treehouse	5. Puzzles and Games	9. Wind Tunnel
2. Memory Game	6. X-ray Machine	10 Gears
3. Reading Hut	7. Discovery Bins	11. Blocks/Mammoth Puzzle
4. Curiosity Cabinets	8. Bird Exhibit Case	12. Dig Box

The specific stations I monitored were the Wind Tunnel, the Blocks/Mammoth Puzzle, the Gears, the Discovery Bins, and the Puzzles and Games. A station is an area in which visitors can engage in scientific learning and structured play in the Discovery

Room. The stations mentioned above all received high traffic during the spring 2013 pilot study.

The Wind Tunnel is a fan that is housed in a table. The fan points upward and the airflow is directed into a clear plastic tube. There is space for visitors to place objects into the fan's air stream. Objects include small plastic strawberry baskets, various sized feathers, small paper lanterns, tulle, various fabrics, and sometimes objects from other stations in the Discovery Room.

The Blocks/Mammoth Puzzle station includes a plethora of blocks of differing sizes. These blocks are stored on a low bookcase close to the floor. The Mammoth Puzzle is a wooden three-dimensional puzzle that visitors can piece together. When it is completed, the mammoth stands approximately three feet tall.

The Discovery Bins feature a variety of different objects in clear plastic bins. One bin features Florida animal figurines, while another includes prehistoric creatures. There is also a bin featuring tubes filled with liquids of differing densities and a bin that includes a vest with internal organs that Velcro to the vest, helping children to understand anatomy. One bin is entitled "Classification" and includes various sized and colored bottle caps. A sheet within the bin explains how the bin works, and this sheet is sometimes read by the guardians of children while exploring the room.

The Dig Box is a three foot high station which features pieces of rubber that cover casts of fossils that can be found in Florida including a horse tooth, a mammoth hip joint, an alligator scute (bony external plate), and a bison metatarsal (ankle bone). Visitors use brushes and magnifying glasses to uncover the fossils. The fossils are also featured on the outside rim of the Dig Box, so when the fossil is uncovered, visitors can read about their find.

The Gears are plastic interlocking pieces that can be placed onto a grid or locked together. Various sized wheels and designs can be made using this station.

The Puzzles and Games station includes a great variety of wooden puzzles, floor puzzles, and other games. A magnetic fishing game and a magnetic game in which the visitor has to place colored balls into the correct pocket are popular at this station. The puzzles and games are grouped together in a low bookshelf that covers the majority of a wall of the Discovery Room.

Other stations in the Discovery Room that were not the focus of this study include: the Memory Game, the Reading Hut, the X-Ray Machine, the Curiosity Cabinets, and the Bird Exhibit Case. These were combined to be "Other Stations" on the Data Observation Sheet. The Memory Game is wall-sized and includes pictures of Florida animals attached to the wall and covered with foam lily pads. Visitors peek under the lily pads and try to match up the animals. The Reading Hut is a representation of a Seminole chickee, or house. Comfortable chairs and beanbags are placed in the Reading Hut along with various books about the natural world, which visitors can read. The Curiosity Cabinets and the Bird Exhibit Case feature nature specimens that can be observed. The X-Ray Machine features animal x-rays donated from a local animal hospital.

Hundreds of research projects are done through and by the museum each year, but research into the importance of the Discovery Room, the room for our young visitors, had not been thoroughly conducted. This research project aims to understand how children use science process skills in this room and use that information to build better exhibits and understanding of children's engagement with science.

In understanding how young children interact with a natural sciences exhibit, we can create better learning environments for them. FLMNH is in the process of fundraising and beginning the creative process for implementing a new children's Discovery Room. My action research project will help researchers, educators, and designers by establishing an understanding of which objects entice children the most and which objects and stations promote the most science understanding. In a pilot study conducted in spring 2013 (*N*=52*)* in FLMNH's Discovery Room, researchers (myself and an undergraduate intern) found that holding time was limited. In the pilot study, we found that the average holding time was between five and ten minutes (Litvintchuok, A., Lundgren, L. Ellis, S. Harvey, A., 2013). This is less than the average holding time found in a large-scale study featuring 108 unique exhibitions. In that particular study, "in 80% of the 108 exhibitions, the average time was less than 20 minutes, regardless of the size or topic of the exhibition" (Serrell, 2010 p. 112). In FLMNH's Discovery Room, there are separate stations that children can visit. None of these stations are staffed by volunteers on a regular basis, although it is staffed on a daily basis by junior volunteers in the summer time. These junior volunteers are tasked with ensuring that visitors do not leave the room a mess. More often than not, visitors engage in free play at the stations.

Although the exhibit is designed to engage children's science process skills, the usage of these skills had not been studied in the exhibit. Science process skills are abilities which engage young learners in the different ways of doing science. Science process skills include observing, inferring, measuring, communicating, classifying and predicting. Further skills include controlling variables, defining operationally, formulating hypotheses, interpreting data, experimenting and formulating models (Litvintchuok et al., 2013). The stations within the Discovery Room are exciting avenues in which children can explore science process skills.

In observations conducted during the pilot study, some visitors engaged the exhibit in non-meaningful ways Some of these experiences included "pinballing." For the purpose of this study, pinballing is defined as occurring when young visitors briefly look at one station (usually less than 10 seconds), quickly move over to another station, and repeat this process for their whole visit, much like a pinball bounces around the machine when being played. Although young visitors were almost always accompanied by an adult during visits, these "pinball" visitors were not "diligent visitors," who deeply explored stations in the Discovery Room (Serrell, 2010). In exploring the usage of science process skills as well as the usage of signage, the Discovery Room could be designed in a way to detract from visitors like these, and instead engage them in meaningful ways.

Research Questions

In order to explore how children use science process skills in FLMNH's Discovery Room, I composed four questions that my action research attempted to solve:

1. To what extent do children use science process skills when interacting with the stations in FLMNH's Discovery Room?
2. What average length of time do children spend interacting with stations in FLMNH's Discovery Room?
3. Which stations in FLMNH's Discovery Room entice children the most?

4. In what ways will increased graphics or directions affect the length of visits and the usage of science process skills?

CONCEPTUAL FRAMEWORK

In order to help guide my action research, I researched studies which featured children in museums, interactive exhibits, and the ways researchers conducted their research in museums. In the following section I will discuss why museum research is important, how children learn, visitor interactions, exhibit labeling, and coding schema in order to elucidate the action research done in FLMNH's Discovery Room.

Why Educational Research in Museums is Important

Before explaining why childrens' exploration of museum exhibits is important, it is critical to explore why research in museums is invaluable. Research was done into models of cognitive development in museums (Callanan, 2012). In her research, Callanan found that museums provide flexible atmospheres to conduct research on cognitive reasoning. Museums also induce learning and provide a place to witness familial conversations concerning education. Callanan discussed research partnerships between museums and universities, where museums allow research to be done because "museum goals overlap with research goals" (Callanan, 2009, 140). Furthermore, university research partnerships with museums are helpful because museums can understand the benefits or shortcomings of their exhibits and then improve exhibits based on the research conducted. The common goals of museum and researchers are summarized by citing access to diversity. A researcher wants to ensure that their research covers a broad base, and museums hope to deliver content to the broadest audience possible. In this regard, research in museums is a mutually beneficial recent development that should continue to be used to the fullest extent.

In understanding how to approach conducting research in the Discovery Room, Callahan's work provided helpful hints for getting the most out of research in a museum. In regards to relationships with museum employees, Callanan says, "Museum professionals know how to communicate clearly with their audiences and can help researchers remove jargon that [they] hardly notice when talk[ing] to colleagues" (Callanan, 2012, p. 146). Relationships within informal environments can vary from those in formal education, and researchers need to understand how to walk the boundaries between formal research and research done in museums. Callahan's study read like an introductory textbook for researchers new to conducting research in museums. She suggested ways to ensure internal review board consent, methodology for documenting visitors, and ensuring that the researcher and the museum have overlapping goals. All of her suggestions help ensure a successful research study is conducted in a museum setting.

Children and Learning

In addition to Callahan's suggestions for successful museum research, the field of child development was researched in order to understand how children learn in museums. Socioculturalism influences many studies done in science museums and other informal settings. Socioculturalism stresses that society can influence the development of an individual (Inagaki, 1992). However, another important theory influencing the teaching of science in informal settings is the Piagetian idea of constructivism. Piagetian theories are the building blocks from which socioculturalism towers. Researchers claim that a science process skill, such as experimentation, can only be applied if experiments that children conduct are based in pre-constructed ideas. Otherwise, “acting on objects without predictions is educationally meaningless” (Inagaki, 1992 p. 119).

Piagetian theory applied to modern day research introduces new components that build upon the original theory, and therefore these theories are called “post-Piagetian.” In post-Piagetian theory, the idea that young children are competent in domains of reason they know well is a main component. In other words, post-Piagetians stress the importance of the content and context in which young children learn science. With this in mind, I examined children’s experiences at FLMNH’s Discovery Room. Understanding a child’s previous experiences with the Discovery Room or other similar spaces in other museums helps inform data analysis because children with previous experiences in the Discovery Room may interact differently with the exhibit than children who have no experience with the room. In conducting research on the Discovery Room, a survey consisting of questions about past experiences with discovery rooms and science museums was used to understand the reasons and the abilities of research subjects. Therefore, the theory of constructed contexts was tied into my action research project.

Visitor Interactions in Museums

Areas of research concerning inquiry skills, families, and museums focused on conversations of family groups. A study done at the Exploratorium, a museum of science, art, and human perception located in San Francisco, California, described the efficacy of data collection when examining family group conversations in a museum (Ash, 2003). In the U.S. National Research Council for Science Learning in Informal Environments’ publication concerning assessment of learning in informal environments, the authors describe Ash’s 2003 study as an example of “theory testing” (Brody, Bangert, and Dillon, 2008). Although this study seems ripe for a methodology review, the methods were too complex to be used in a study of my magnitude. Videotaping interactions was not a feasible approach for FLMNH's Discovery Room. Therefore, Ash's paper was examined for its research on family conversation about science.

In Ash's 2003 study, researchers examined how an exhibit's multiple zones of proximal development could benefit and improve familial conversations in an exhibit. Ash indicates that when an exhibit contains different levels of talking points, labels, or hands-on activities, the exhibit has multiple zones of proximal development. The different zones indicate that a diverse group of people can enter into and explore the exhibit in a multitude of ways.

Ash approached subjects through a microscopic lens, choosing to examine only three families. She claimed that a three-family approach would allow her to conduct a "fine-grain analysis" of family conversations (2008 p. 138). Ash's work is based on the Vygotskian theory of socioculturalism, where "learners navigate with aid from supporting contexts, including people" (2008 p. 139). In this context, Ash sought to understand the intersections between conversations between parents and children, as well as interactions between families and the exhibits, to understand how knowledge is constructed and taught when a family visits a science museum. The research showed that examining family groups by coding for context as well as coding family contributions to science learning helped solidify the Vygotskian theory of socioculutralism. Families in museums learn and internalize their experiences through three "representative dialogic segments (RDS): questions, reflective narration, and scaffolding" (Ash, 2003 p. 153). In the context of the Exploratorium's exhibit, families used their RDS's to understand adaptations, life cycles, and skeletal structures.

Ash's research at the Exploratorium influenced my action research study by giving me more theoretical background into science museums and education in an informal setting, as well as providing background for the area I studied: family interactions in a science museum. Many Discovery Room visitors are quite young and may not explicitly use science process skills themselves. Instead, they learn these skills from their parents and peers--even if their "teachers" are unaware that they are teaching science process skills. Therefore, an aspect to my study concerned parental guidance in terms of science process skills. Do the parents ask scientifically meaningful questions? Do they scaffold their children's inference skills? By reading Ash's study, I found valuable information concerning these ideas.

Labeling in Museum Settings

Studies which explored visitor interactions and labels in science museums were valuable to my project. These studies provided methodology to use, best practices for observations, and cautions about label usage in a museum setting. For instance, research into exhibit labeling shows that labels frame the activities that visitors engage in as well as influence the types of conversations visitors have while at museums (Atkins, 2009).

In examining the effects of labeling exhibits, researchers studied the conversations and interactions visitors had with an exhibit featuring a heat camera. The exhibit featured a setup with a simple label with no explanation some of the time, and a framed exploration concerning mittens and insulation at other times. Researchers discovered that when the exhibit included a label with a specific idea for visitors to explore, visitors chose to explore that idea, but did not engage as often in extraneous observations or inquiries. Visitors only launched into investigations suggested by the label, as if the exhibit were the schoolteacher conducting a lesson. Visitors were required to learn certain content, but when they had exhausted that content, they would continue to a new exhibit to receive a new lesson. In other words, “visitors follow instructions regardless of their understanding of the intent of the instructions and to the exclusion of doing what they find interesting at the exhibit” (Atkins, 2009 p. 178).

On the other hand, visitors who did not experience the labeled heat camera exhibit were prone to conducting novel explorations and investigations concerning objects in the exhibit, objects on the person, as well as on outside objects such as snow and wet paper towels. In essence, the researchers found that in the heat camera case, having a specific label with a ready-made investigation stifled science process skills and investigations (Atkins, 2009 p. 178).

The research suggested the impact of labeling: “by suggesting a sequence of steps and an explanation for the resulting observations, visitors identify what it is they are ‘supposed to do,’ do this, and leave” (Atkins, 2009 p. 179). In the Discovery Room, I considered designing a label asking visitors the best way to build a parachute in a wind tunnel, similar to a label I had seen at the Science Museum of Minnesota. I considered a label encouraging visitors to design the highest and sturdiest block tower. Because researchers found that exhibit labels tended to narrow visitors’ approaches to investigation, I was inclined to be more careful in my exhibit labeling. The research suggested labels can and should be used in museums, although they may come at the price of “collaborative activity and excitement” (Atkins, 2009 p. 181).

Coding Methodology

In another study conducted at the Exploratorium in San Francisco, CA, inquiry process skills were examined. In this study, researchers examined how the introduction of inquiry games to specific exhibits affected the use of science process skills (Gutwill and Allen, 2009). Researchers looked at the two games' effects on visitors' performance of "proposing actions" such as asking questions and making plans in the exhibit, as well as "interpreting results" such as observations, interpretations, or explanations (Gutwill and Allen, 2009 p. 713). In their study, researchers used four "broad spectrum" exhibits, meaning that they were "open ended," "multioption," and "multiuser" friendly. The exhibits were chosen for this study because "these exhibit characteristics often lead to more visitor-driven investigation" (Gutwill and Allen, 2009 p. 718-719).

The study's methodology consisted of four distinct stages. First, visitors included in the study would enter into the first of four exhibits. In this exhibit, entitled "Shaking Shapes," the families free-played, which means that the families explored the exhibit at their leisure with no instruction or guidance into how to use the exhibit. Next, visitors were divided into one of four groups. The first group received instruction into playing the inquiry game called "Juicy Question." In this inquiry game, visitors were tasked with exploring an exhibit, then coming up with an interesting question to explore as a group in the exhibit. Group two was introduced to the inquiry game "Hands Off!" in which a visitor could stop the group and ask to explore a topic of his/her interest. The third group experienced a short, informational, guided tour of the exhibit. The tour docent was given specific instructions to not include any inquiry learning themes in their tour. The last group was a control group that was not given inquiry games or a guided tour. After the groups were divided, they were allowed to explore the exhibits “Floating Objects” and “Unstable Table” freely. The last exhibit, “Making Waves,” served as the “post-test” for the study, where families were videotaped and their inquiry behavior was recorded.

The coding schema used in this study is a key component that was modified for my action research study. Researchers developed a code of five behaviors. First, researchers looked at *engagement.* For this code, researchers measured “the length of time a family chose to spend at the exhibit (i.e., holding time)” (Gutwill and Allen, 2009 p. 720). Next, researchers coded “proposing actions (spontaneous use of skill 1)” (Gutwill and Allen, 2009, p. 720). With this, coders could watch for the utterances of families when they asked questions, or asked questions and then stated the desired result of the action (referred to as low and high proposing actions). The behavior of “interpreting results (spontaneous use of skill 2)” was also recorded. This code was separated into low and high utterances. Families were also watched for “collaborative explanations” where family members would respond to another’s interpretation of results within two seconds, adding to the original interpretation. Lastly, researchers coded “coherent investigations” in which experiments were linked so that the proposing actions were joined in a chain. For example, if a child indicated that they wanted to make a wave pattern in the “Making Waves” exhibit, and then followed that investigation with another theory as to how to make the shortest wave, the child would be conducting a coherent investigation.

This study also sought to understand how participants viewed their experiences. They studied this through asking participants to self-report. These self-reports took the form of interviews and surveys. A demographic survey was employed to examine if "demographic variables interacted with the treatments" (Gutwill and Allen, 2009 p. 721). The additional interviews took place immediately after completing the post-test in the "Making Waves" exhibit. Researchers randomly selected a child and an adult from each participating group to interview. "These interviews focused on what they liked and disliked about the experience and, if applicable, about the game they learned" (Gutwill and Allen, 2009 p. 721). The methodology was not described fully, so we do not know if Likert scales or simple interview questions were used. In this regard, post-assessment interviews were incorporated into the Discovery Room action research project. However, instead of interviews, an iPad and a Qualtrics® Online Survey were used (Qualtrics, Provo, UT). Qualtrics® is a program that is similar to SurveyMonkey® or other survey sites.

Study Methods

Additional sources were taken from an article that synthesized data (Brody et al, 2008). This National Research Council-commissioned article featured a number of studies. Plus, the article's authors used matrices to illuminate each study's foci, and data collection methods, as well as other helpful features. The authors succinctly summarized why this type of article is necessary for inclusion in a capstone paper: "In general we can say that when the researchers are clear in describing the sample studied and the reasons for the investigations, there is alignment with the assessment methodologies and data acquisition methods" (Brody et al., 2009, p. 26). Their point is that by conducting a thorough examination of many articles, other researchers will be able to utilize these studies better. For research concerning the Florida Museum of Natural History's

Discovery Room, this article provided sources, data collection methods, and graphs which showed previous studies that had been published concerning informal education.

Data Collection

Data collection is a main component of action research, so further study was done into other researchers' methods of data collection. A study on preschoolers and their parents was conducted at Science Center NEMO in Amsterdam, The Netherlands. In this study, the "exploratory behavior scale (EBS)" was developed in order to understand how preschoolers interact with hands-on exhibits (Van Schijndel, Franse, and Raijmakers, 2010). Researchers sought to observe how young museum visitors displayed different levels of interactions with museum exhibits. Observation coding was based on a pyramidic scheme. Passive contact formed the bottom level, active manipulation formed the middle, and exploratory behavior formed the pyramid peak. In passive contact, "a child walks, stands, sits or leans on something and may hold or transport an object. However, the child does not manipulate the object in an active and attentive manner." When describing active manipulation, researchers wrote, "a child manipulates an object in an active and attentive manner. This implies that the child pays attention to his or her action(s) and the outcome(s) of the action(s)." Lastly, exploratory behavior was described as an addition to active manipulation: "the child applies repetition and variation to his or her actions" (Van Schijndel, Franse, and Raijmakers, 2010 p. 799).

Parental involvement is crucial to young learners' understanding of the science exhibits at NEMO, so researchers developed two experiments to elevate parental guidance in the exhibits. In the first experiment, parents were shown a short instructional video concerning coaching children in a science museum. Experiment two was the control and featured parents visiting the museum with their preschoolers. Data collection methods consisted of data sheets and video coding. Researchers found that one exhibit in both experiments featured more active manipulation: the “Rolling Rolling Rolling” exhibit, in which children roll cylinders down diverse surfaces to test the speed of the cylinders. In the other exhibit featured, “Spinning Forces,” children exhibited passive contact, watching different objects on spinning tables. Furthermore, researchers found that different styles of coaching allowed for different levels of improved contact with the exhibits.

When researchers and parents employed techniques to guide learners in the “Spinning Forces” exhibit, more active manipulation was observed. On the other hand, in the “Rolling Rolling Rolling” exhibit, even if children only received minimal explanation, children used exploratory behavior to understand the exhibit. The researchers do not address why the children were more active in the “Rolling Rolling Rolling” exhibit. However, the exhibit features a dynamic interaction: cylinders are moving down ramps and the visitor controls how fast they do this. The dynamic interaction in the exhibit could have been a contributing factor to active manipulation.

In total, the articles featured above helped shape the research project in the Florida Museum of Natural History’s Discovery Room. Theoretical articles that discussed constructed contexts informed my data collection instruments, methodological articles on various museums sparked ideas for data collection methods, and articles about museums as hubs for cognitive development provided extra background to my project.

METHODOLOGY

In order to explore my research questions, I created three distinct data instruments and used Field Notes.

Table 2
Data Triangulation Matrix

Research Question	Data Source During Visit	Data Source Post-Visit
Primary Question: 1. To what extent do children use science process skills when interacting with the objects in FLMNH's Discovery Room?	Data Observation Sheets Field Notes	Qualtrics® Online Survey
Secondary Question: 2. How much time on average do children spend interacting with objects in FLMNH's Discovery Room?	Data Observation Sheets	Qualtrics® Online Survey Museum Demographics Survey
Secondary Question: 3. Which objects entice children the most?	Data Observation Sheets Field Notes	Parent Interviews
Secondary Question: 4. In what ways will increased graphics or directions affect the length of visits/the usage of science process skills?	Data Observation Sheets Field Notes	Qualtrics® Online Survey

As Table 2 shows, different data instruments were used to collect data about science process skill usage in the Discovery Room. The primary instrument used was Data Observation Sheets. These were used during every observation conducted in the Discovery Room. Four components were necessary to conduct observations in the Discovery Room: the Data Observation Sheet, a stopwatch, signage for the Blocks Corner and the Wind Tunnel, and an iPad with the Qualtrics® Online Survey queued up. The blocks signage was attached to the wall near the Blocks corner. The wind tunnel sign was attached to the Wind Tunnel.

Each interactive station was included on the Data Observation Sheet (Appendix A). Science process skill usage could be recorded if children visited any stations. Observations were started by recording the number of adults and children in the room as well as the date and time of the observation. Observation began with the next family group that crossed the threshold of the Discovery Room. Then, the observer would wait for ten seconds and start the stopwatch. Observers, who included a team of four interns and myself, recorded science process skills (SPS) that children used when interacting with the Wind Tunnel, Blocks, Discovery Bins, Dig Box, and Gears. SPS were used in other stations, and those observations were recorded in the box on the Observation Sheet labeled “Other Stations”.

The time that was spent at a single station was recorded and the stopwatch reset when the child explored a different station. If a child visited a station more than once, the times were recorded by placing commas between each time. For example, if a child visited the Wind Tunnel for a minute and thirty-two seconds, went to another station, and then returned to the Wind Tunnel for an additional two minutes and six seconds, the time was recorded as 1:32, 2:06. This way, data was examined for patterns concerning dates, ages, and science process skills.

This study also asks how signage could affect science process skill usage and/or length of visits. I created signs that our young visitors could engage with, and during observations placed these signs at young visitor eye-level. The signs were taken down after each observation period. This safeguarded against the possibility of visitors engaging with the signage when an observer was not in the room. The only times in which visitors could attempt to recreate the objects depicted in the signage occurred when observations were ongoing. Figures 1a and 1b show the signs that were used for this study.

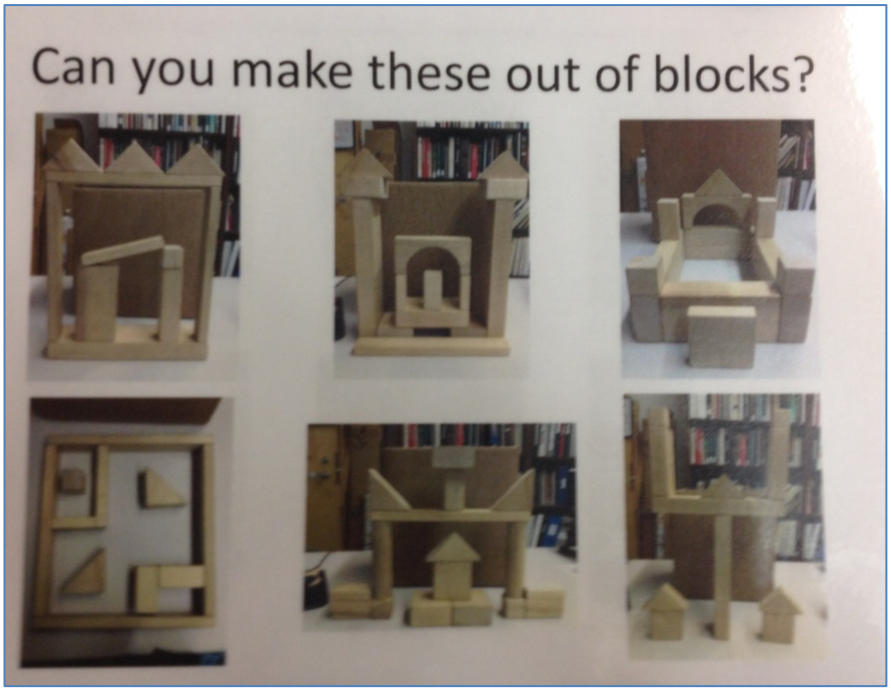


Figure 1a. Blocks Corner Signage.

Figure 1b. Wind Tunnel Signage.

The graphic for the Wind Tunnel was placed on the side of the table that houses the Wind Tunnel. For the Blocks, I designed signage that was at eye level for young visitors, depicting different types of structures that could be built with blocks.

In order to understand how visitors see and use the room, I conducted surveys and interviews. Alternating visitors were asked to respond to the Qualtrics® Online Survey (Appendix B) or a Parent Interview (Appendix C) but not to both in order to save visitors time during their museum visit.

Visitors who responded to the Qualtrics® Online Survey were asked to respond to a series of questions about which objects or stations their child interacted with in the Discovery Room. If their child interacted with that object or station, the parent was asked questions about their child's interaction with the station or object, such as: "While visiting the wind tunnel, I saw my child use at least one of their five senses as they explored the objects in the wind tunnel: *Not At All, A Little, Some, A Great Deal, Most of the Time, Not Applicable.”*

These online surveys allowed me to get feedback about parental viewpoints. The online surveys also asked parents to identify what they thought of as important skills for their children, such as observing, predicting, and classifying. Furthermore, the Qualtrics® Online Surveys asked parents to indicate if their children were using science process skills in the museum. This overlapped with the purpose of the Data Observation Sheets and the Parent Interviews. The overlapping questions about science process skill usage, as well as the usage of signs, helped to insure that the data I collected was more valid. In analyzing this data collected by the Qualtrics® Online Survey, I was able to understand if parents are utilizing the Discovery Room in the way museum educators designed it.

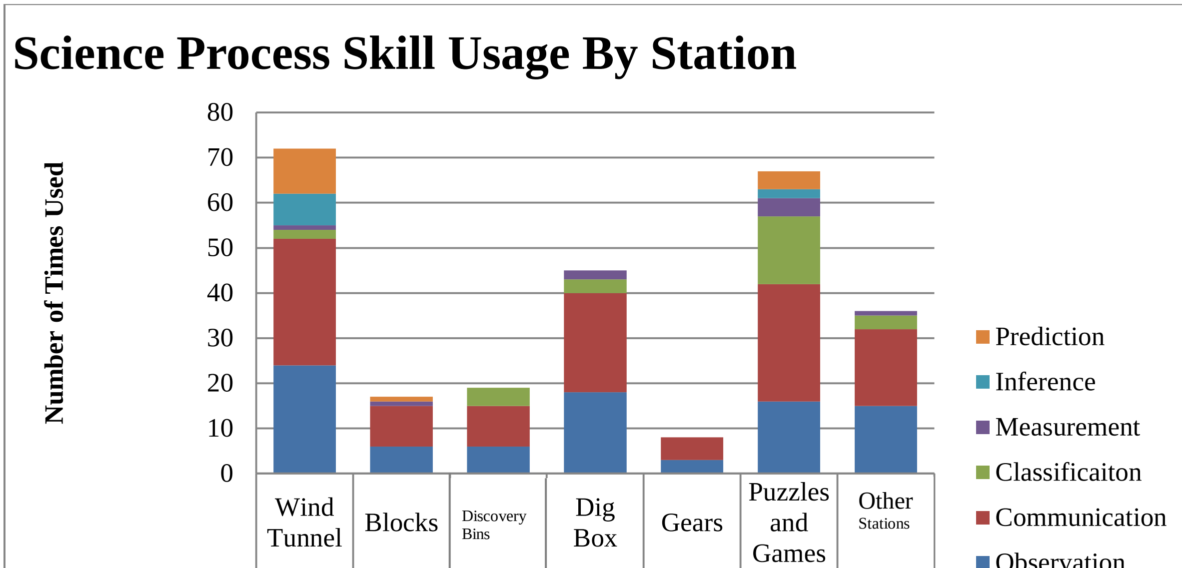
The families that were not asked to complete a Qualtrics® Online Survey were asked to complete the Parent Interview after their visit. These visitors were asked about their favorite objects in the room, what they enjoyed most about their objects, as well as what sorts of science process skills they used while visiting the room. Those who were interviewed were asked if they noticed the graphics, therefore contributing to understanding as to whether or not the graphics were a vital component to their Discovery Room visit.

Observations were collected from July 7, 2013 until November 24, 2013. Most observations were collected on Sunday afternoons between the hours of 1pm and 5pm, but 37 percent of observations *(N*=21*)* were collected on other days of the week based on the availability of interns who collected data. Reliability in the data collected by interns was tested when interns were paired up with me for the first two observations they conducted. Each person would independently code on the Data Observation Sheet, using the same subject. After the subject finished their visit, I met with the intern to see if we recorded the same sorts of science process skills as well as utterances of the subject. If the intern and my data did not match up, that piece of datum was not used. After each intern and I successfully completed an observation together, the intern could collect data independently. It was not practical for me to record with the interns during every observation they conducted, but using this form of inter-rater reliability helped data collection. Data collection included both genders of children. Observations including males made up 31 of the observations, while data collected on females consisted of 22 observations. Three observations did not record information on the gender of the child being observed (*N*=56). The research methodology for this project received an exemption by Montana State University's Institutional Review Board, and compliance for working with human subjects was maintained (Appendix D).

DATA AND ANALYSIS

As stated in the Methodology section of this paper, three distinct data collection sources and field notes were used. In this section, the Data Observation Sheet, the Parent Interview, and the Qualtrics® Online Survey will be examined. The examination of these collection instruments will provide data that will answer the research question, "To what extent do children use science process skills when interacting with the objects in FLMNH's discovery room?" as well as the research sub-questions.

The data revealed that the most prominent science process skills used in the Discovery Room were observation and communication. In Figure 2, a stacked bar graph depicts all instances of the science process skills which were recorded on the Data Observation Sheets.



	Wind Tunnel	Blocks	Discovery Bins	Dig Box	Gears	Puzzles and Games	Other Stations
Prediction	10	1	0	0	0	4	0
Inference	7	0	0	0	0	2	0
Measurement	1	1	0	2	0	4	1
Classificaiton	2	0	4	3	0	15	3
Communication	28	9	9	22	5	26	17
Observation	24	6	6	18	3	16	15

Figure 2. Science Process Skill Usage by Station, (*N*=56).

As Figure 2 shows, the Wind Tunnel featured the most science process skill usage. In 46 out of 56 observations, the skill of observation was recorded and often recorded at multiple stations for the same visitor. Communication was recorded in 50 out of 56 observations and totaled 116 distinct utterances of communication at unique stations. In contrast, the skill of prediction was recorded in 15 out of 56 observations. Prediction is a more complicated skill because it requires children to observe then communicate about the station. Prediction is an educated guess about the outcome of a future event. In their actions, children have to examine the world around them then figure out what happens next. Often, this can be difficult for children to accomplish in meaningful ways and the skill was rarely seen.

Observation and communication were used in a variety of ways at the Discovery Room stations. As a science process skill, observation is using the five senses to make qualitative or quantitative statements about the station and its contents. When observing at the Wind Tunnel, one visitor exclaimed, “The green box went all the way to the ceiling!” In this datum, we see that the visitor observed the height, color and variety of material that they put in the Wind Tunnel, making qualitative statements about their experience. Other visitors would express their delight at watching items fly by exclaiming: “It’s flying, it’s flying!” depicting two science process skills: observation and communication. “It goes so high,” is another visitor’s expression of a qualitative experience at the Wind Tunnel: the height of the object as it is buffeted by the wind.

Observation was not limited to the Wind Tunnel. Visitors observed the qualities of the Dig Box, saying “I think that this is real sand that you can dig through to see fossils. Oh wait, this isn’t sand, this is bits of rubber, like from the playground.” Other visitors discussed what they were doing at the Dig Box saying, “I’m finding bones.” These sorts of observations extended to the fishing game in the Puzzles and Games station. Many children observed (and then communicated): “I got a fish,” when using the magnetic poles to catch the magnetic fish.

Across the seven stations, communication was the most widely used science process skill. As illustrated above, observation and communication are often interrelated. A visitor may use their five senses at the station, and they will often then tell someone about it, which is the science process skill of communication. In the 56 observations conducted and analyzed, this skill was used 28 times at the Wind Tunnel, 9 times at the Blocks/Mammoth Puzzle, 9 times at the Discovery Bins, 22 times at the Dig Box, 5 times at the Gears, 26 times at the Puzzles and Games, and 17 times at Other Stations.

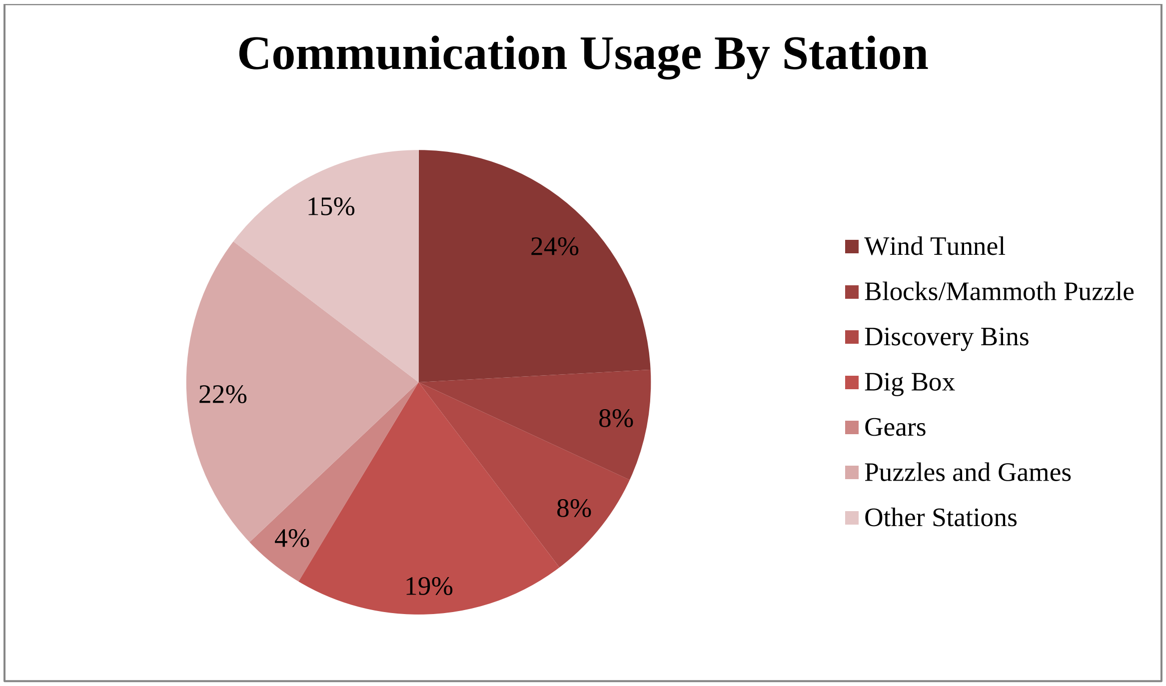


Figure 3. Communication Usage by Station, (*N*=116).

In Figure 3, the percentage in which a visitor used communication while at a station is represented. This graph does *not* represent repeated uses of communication at a single station. For instance, if a visitor at the Wind Tunnel spoke to their guardian about how a feather floated in the Wind Tunnel, that instance was recorded as the science process skill of communication on the data analysis sheet. If that same visitor communicated again about a different object's movement in the Wind Tunnel with their guardian or another visitor in the room, this instance was not recorded.

Communication is defined as "using words or gestures to describe experiences at the station." Visitors' words or gestures ranged from simply describing what they could do at the station: “And you can stack them upside down” when playing with the stackable turtles in the Puzzles and Games station, to exclamations of delight: “Look, momma! I finished the puzzle!” when exploring a puzzle in the Puzzles and Games station. One child said, “See, I can build stuff here” when using the Blocks/Mammoth Puzzle station. All these are examples of visitors using words to describe experiences at the station. Communication was the most widely used science process skill because most of the other science process skills utilize communication: visitors communicate about their observations, their classifications, their measurements, their inferences, and their predictions.

Some visitors would use the skill of communication to discuss classification. When a child said, “I caught a fish, it’s a swordfish!” while using the magnetic fishing game in the Puzzles and Games station, that child was sorting the objects at the station into groups. Children also classified objects at the Dig Box, saying, “That’s a horse tooth,” when pointing at the horse tooth in the Dig Box. Classification was also recorded in children interacting with the Discovery Bins. Visitors arranged animals into groups, offering explanations such as “This is a dinosaur, but this is a shark.”

Rarely, visitors extended their communication skills to the realm of inference and prediction. Inference is “an explanation or interpretation of an object’s behavior based on observations.” Prediction is “an educated guess about the outcome of a future event” (Lundgren, 2012). From the data collected on the Data Observation Sheets, inference was recorded nine times, seven of which were recorded at the Wind Tunnel and two of which were recorded at the Puzzles and Games. Prediction was recorded 15 times: 10 times at the Wind Tunnel, 4 times at the Puzzles and Games and once at the Blocks/Mammoth

Puzzle. A specific inference incidence occurred when a child exclaimed, “The box is heavy ‘cause of what’s in it!” This child was explaining the reason for a strawberry basket being heavy. Another incidence occurred when a child said, “The white feather is so light it flies up high.” This inference, although incorrect, is another example of a visitor attempting to explain the behavior of an object at the Wind Tunnel station.

The most visited stations, as depicted in Figure 4, were the Wind Tunnel and the Dig Box, closely followed by the Puzzles and Games and Other Stations.

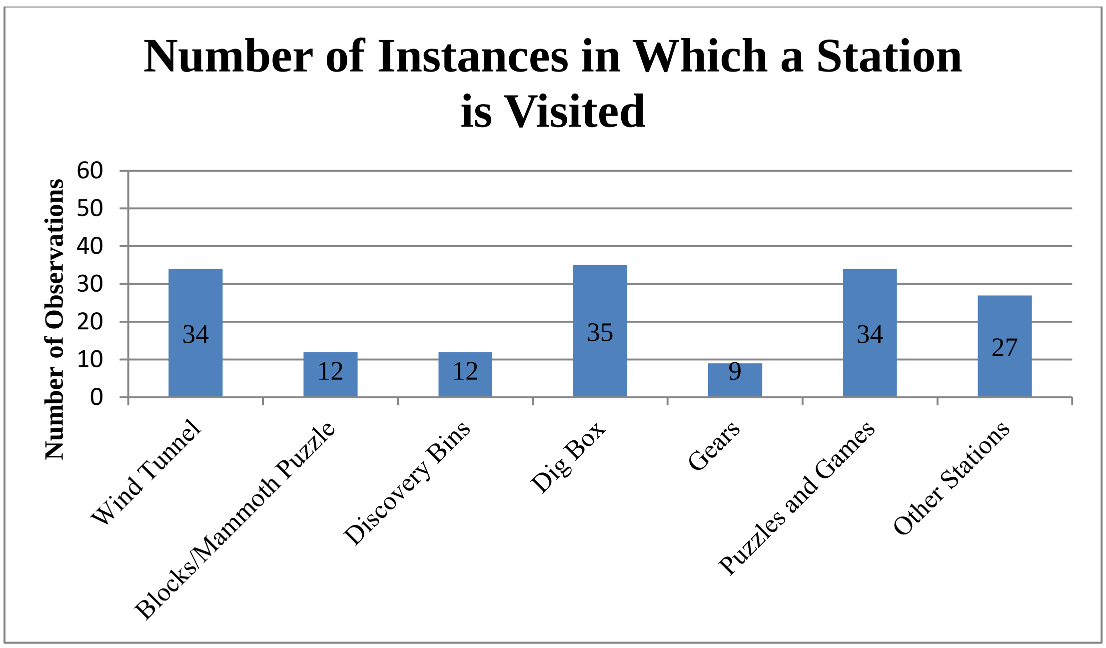


Figure 4. Number of Instances in “Which a Station is Visited”, (*N*=56).

In Figure 4, the number of observations in which a station was visited is explored. The most visited stations were the Wind Tunnel, the Dig Box, and the Puzzles and Games. The Wind Tunnel was visited 60 percent of the time, while the Dig Box was visited 62.5 percent of the time.

Research concerning time at each station was conducted in order to answer the research question, “Which objects entice children the most?” research concerning time at each station was conducted. Figure 5 depicts stations at which children spent the most amount of time. This was calculated by reviewing the Data Observation Sheets and adding the times that were spent at each station. The time was recorded in seconds, so the time spent at the most popular stations is shown in seconds in Figure 5.

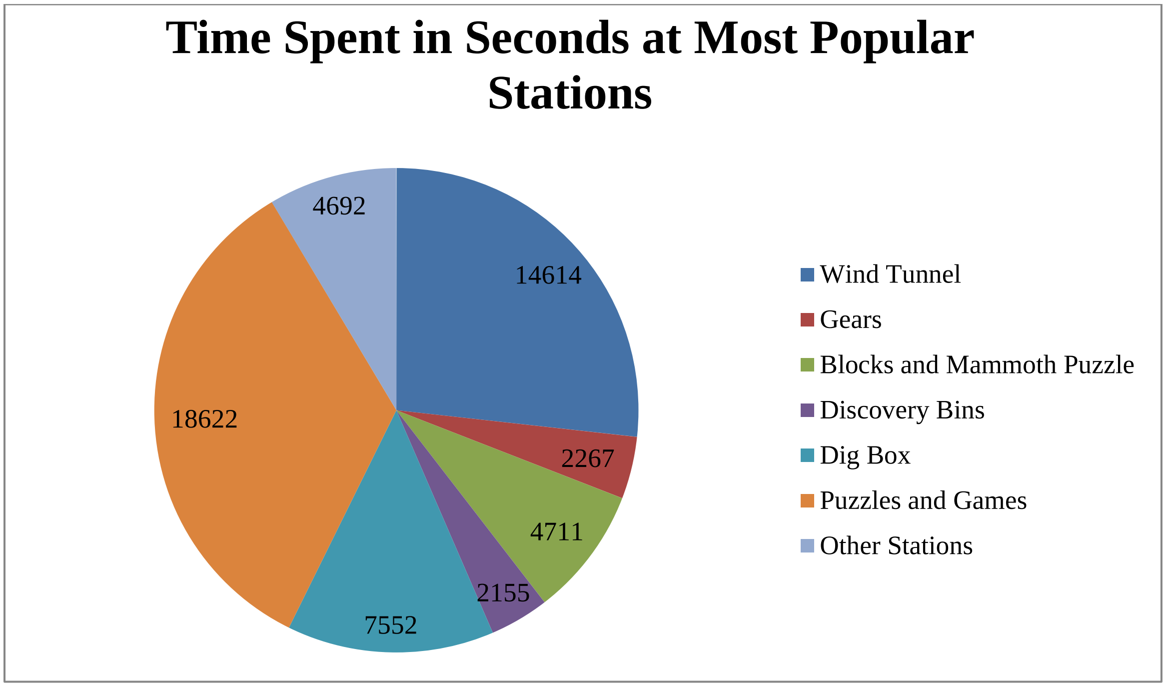


Figure 5. Time Spent in Seconds at Most Popular Stations, (*N*=56).

In spending more time at one station than others, the visitor indicated that they were interacting more with that station. All stations all equal in their value, meaning that a visitor could spend as much time at one station as they could at another. The stations do not have set time limits in which it takes to explore them. Blocks can be created in numerous patterns just as myriad numbers of objects can be tossed into the Wind Tunnel. However, visitors chose to spend more time at specific stations: the Wind Tunnel and the Puzzles and Games.

Although few science process skills were used at the Blocks and Mammoth Puzzle, the visitors who interacted with this station stayed for a long time. Data indicates that visitors stayed at the Blocks and Mammoth Puzzle for a combined 4,711 seconds (78 minutes and 51 seconds). This indicates that the Blocks and Mammoth Puzzle are a popular installation in the Discovery Room. However, the science process skills used at this station are lacking: visitors only used observation and communication when exploring the station.

When researching the Discovery Room, the Wind Tunnel and the Blocks/Mammoth Puzzle were subject to additional signage. Signage was added in order to study the research question, "In what ways will increased graphics or directions affect the length of visits/the usage of science process skills?" This research question was answered when guardians responded to the Qualtrics® Online Survey. Fifteen parents participated in taking the Qualtrics® Online Survey, which was designed in a Likert-survey format, asking parents to rank experiences in the room. The questions pertaining to signage were, "The signs depicting different ways to build objects were beneficial to my child's experience at the wind tunnel…*Not At All, A Little, Some, A Great Deal, Most of the Time, Not Applicable"* and "The signs depicting various block buildings were used by my child when playing with blocks…*Not At All, A Little, Some, A Great Deal, Most of the Time, Not Applicable."*

When responding, the guardians whose children engaged with the Wind Tunnel indicated that more often than not, the signs at the Wind Tunnel were not beneficial to their child's experience at the Wind Tunnel. Figure 6 is a graphical representation of Qualtrics® Online Survey responses.

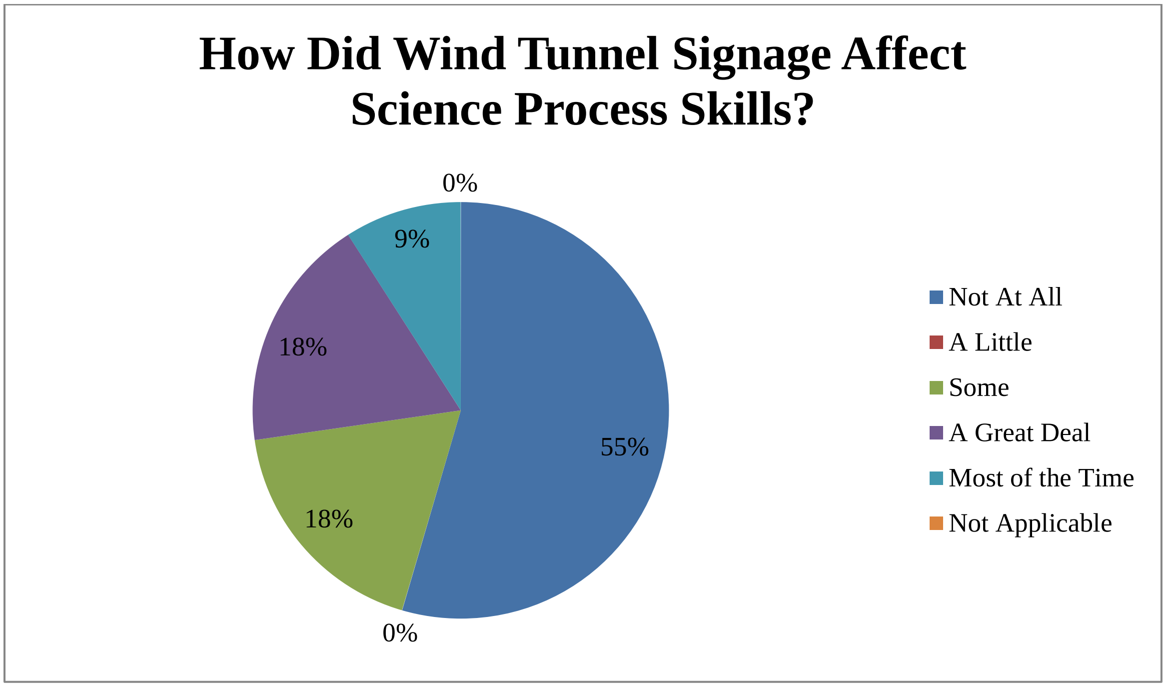


Figure 6. How did wind tunnel signage affect science process skills?, (*N*=11).

As indicated by the Qualtrics® Online Survey, parents responded that the signage at the Wind Tunnel did not have benefits for their children when they explored the Wind Tunnel. Data from the Data Observation Sheets also correlates to Qualtrics® Online Survey parental responses. The exploration of signage at the Wind Tunnel was recorded in one specific observation. The parent directed the child to look at the signage then helped the child make the parachute depicted on the sign using a strawberry basket and a piece of cloth. However, no other instances of children regarding the imitating the pictures on the signage were observed.

In addition to the Wind Tunnel signage, the Blocks/Mammoth Puzzle area featured signage. This station was frequented less than the Wind Tunnel, so the amount of parents who indicated their child interacted with the blocks was lower than the Wind Tunnel. Those parents who indicated their child interacted with the Blocks/Mammoth

Puzzle were more evenly split on how their children interacted with the signage. Figure 7 is a graphical representation of parental responses to the Qualtrics® Online Survey question concerning the signage at the Blocks/Mammoth station.

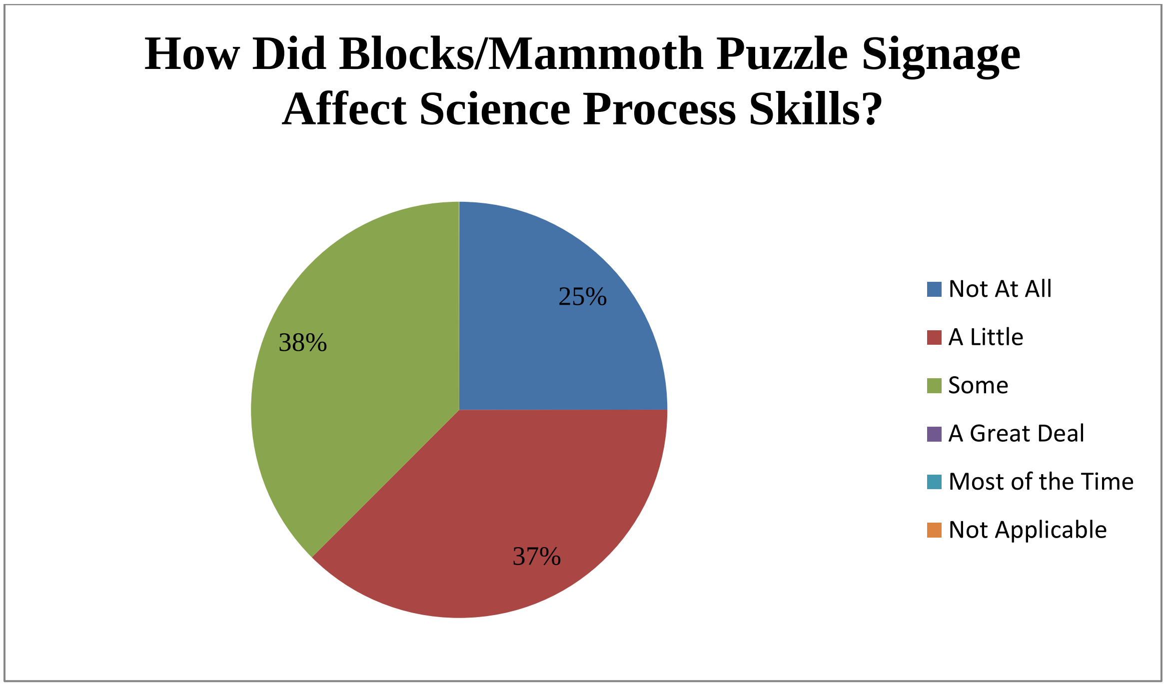


Figure 7. How did blocks/mammoth puzzle signage affect science process skills?, (*N*=8).

Most parents who responded that their child interacted with the blocks and used the signage indicated that their child only used the signage "a little" and "some." Twenty-five percent of parents indicated that their child did not use the signage at the blocks station at all. Parents were almost evenly split about their child's interaction with the signage and if it affected their experience. However, they were all split along the same lines: the ways in which the signage affected their child were minimal; the degree of the minimal affect was quibbled over. No parent indicated that the signage was used "Most of the Time" when their child interacted with the Blocks/Mammoth Puzzle station.

In order to explore the research questions about science process skill usage, station enticement, and the usage of graphics, the Parent Interview was used. The demographics collected by the Parent Interview (*N*=35*)* indicated that the majority of visitors sampled and asked to complete the Parent Interview were white and between the ages of 26-40. The ages of children who participated in this action research project was not asked, but rather approximated by infant, toddler, preschooler, or elementary school child. Figure 8 gives a graphical representation of the ethnicities of those who partook in the Parent Interview.

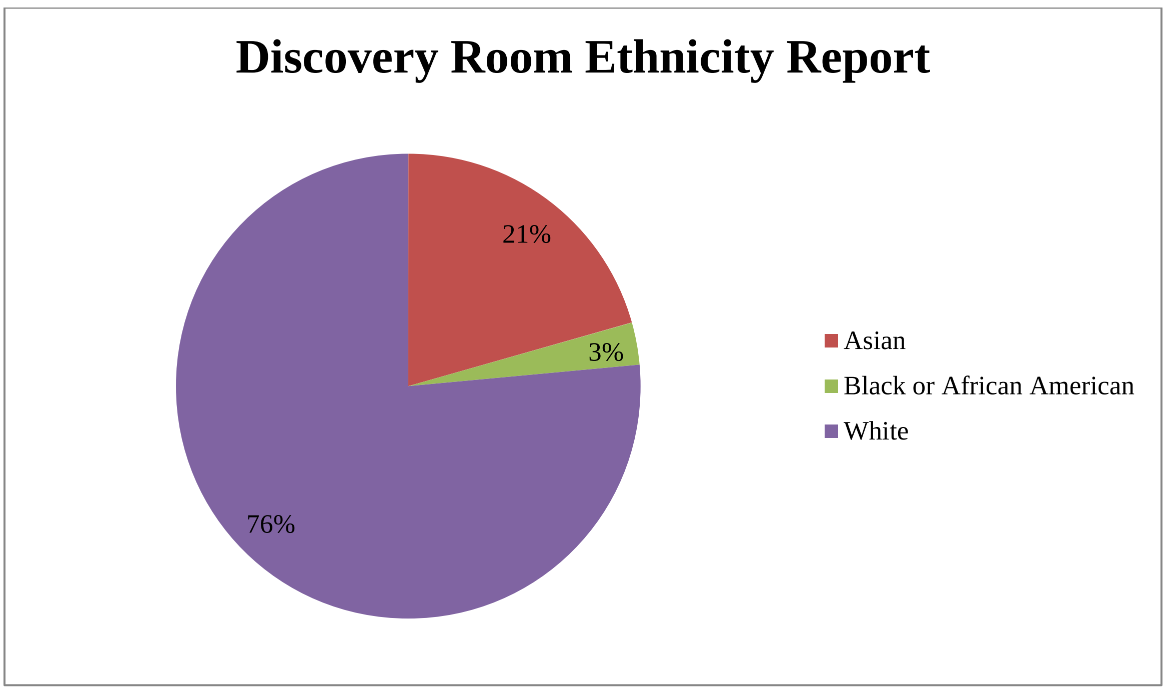


Figure 8. Discovery Room Ethnicity Report, (*N*= 35).

As indicated by Figure 8, most visitors identified themselves as Caucasian (76 percent), while 21 percent identified as Asian, and three percent identified as Black or African American and other, respectively. These percentages reflect consistency when examining Florida Museum of Natural History visitors as a whole. In a visitor survey conducted in the spring of 2013 (*N*=189*)*, surveyors found that 87.3 percent of visitors surveyed indicated that their racial identity was white whereas 2.6 percent self-identified as Asian. Visitorship of Asian families therefore, was higher in the Discovery Room.

There does not seem to be any correlation between ethnicity and the usage of basic science process skills. In the data observation sheets, which included data on ethnicity (*N=35)*, 28 participants used the skill of observation, while 31 participants used communication. Asian participants made up seven of the data points, and in every instance, these participants used both communication and observation. However, in examining how often participants with recorded ethnicity data used the skill of prediction, white participants used the skills more often than Asian participants. In the eight recorded instances of prediction, seven of the instances were recorded in white visitors, while only one was recorded while observing an Asian visitor.

In order to further explore the research question “Which stations in FLMNH’s Discovery Room entice children the most?” the Parent Interview asked: “In what area do you think your child spent the most time?” This was done in order to get parental feedback about their child’s visit and to see if the data collected from the Observation Sheets aligned with the ideas that parents had. Data analysis of the Observations Sheets showed that children spent a majority of their time interacting with the Wind Tunnel, the Puzzles and Games, and the Blocks/Mammoth Puzzle. Parent Interviews (*N*=33) indicated that parents thought their children spent the most time interacting with the Wind Tunnel, the Puzzles and Games, and the Dig Box. Figure 9 showcases how parents responded to this question on the Parent Interviews.

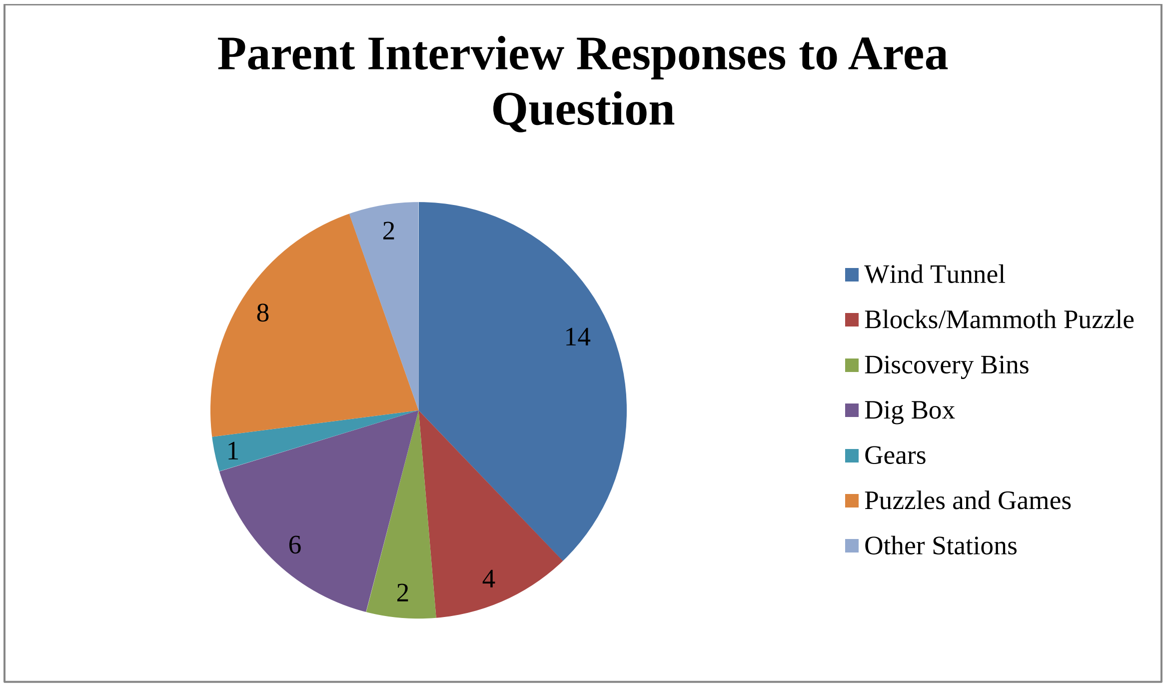


Figure 9. Parent Interview Responses to Area Question, (*N*=33).

Figure 9 shows the correlation between parent responses and actual data collected in the room. It was observed that children spent more time at the Wind Tunnel than other stations and parent responses indicated that they, too, noticed that their child spent more time at the Wind Tunnel. The Wind Tunnel sometimes breaks and needs to be repaired. When the Wind Tunnel was gone on observation days, parents and children who had visited previously and interacted with the Wind Tunnel often asked the observer about the Wind Tunnel or commented on its absence. One parent said, “He misses the Wind Tunnel” while another commented, “[She usually] plays at the Wind Tunnel, but today, she explored the Dig Box.” These quotes illustrate that parents notice their children interacting with the Wind Tunnel. While other stations were mentioned when asked about, the Wind Tunnel was the only station in which parents commented about its absence or the fact that their children liked it. All other stations did not receive these types of comments.

Further research into which objects enticed visitors and to what extent children used science process skills was done through the Qualtrics® Online Survey. As discussed previously, fourteen parents participated in the Qualtrics® Online Survey. Parents were asked if their child used specific stations: the Wind Tunnel, Blocks/Mammoth Puzzle, the Discovery Bins, and the Dig Box.

The first question asks parents the extent to which their child explored scientific concepts in the Discovery Room. This question was asked to understand two concepts: if parents think the Discovery Room is a room to be used for scientific purposes and if the parents thought that their child explored scientific concepts. Both of these concepts relate to the research question, "To what extent do children use science process skills in FLMNH's Discovery Room?" In order to explore a scientific concept, one must use some if not all of the science process skills: observation, communication, classification, measurement, prediction and inference. In responding to the question presented on the Qualtrics® Online Survey, parents were indicating both that their child explored a scientific concept and the fact that they were using science process skills to do so. Figure 10 shows parents' responses to this question.

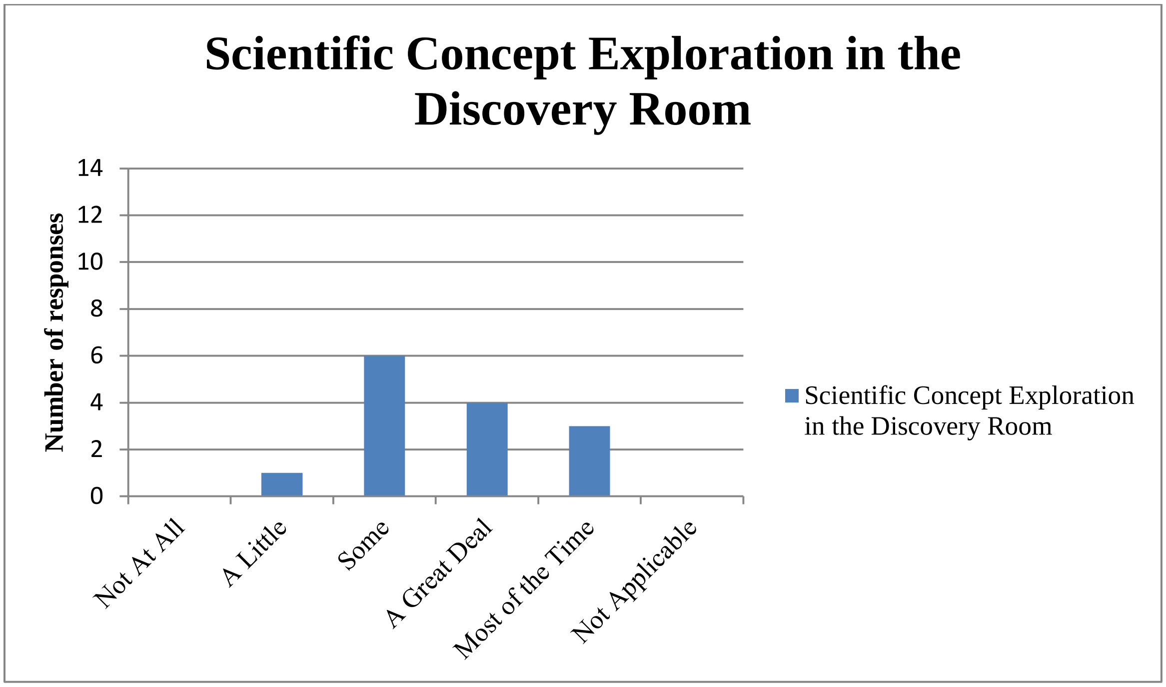


Figure 10. Responses to Qualtrics® Scientific Concepts Question, (*N*=14).

The majority of parents indicated that their child explored scientific concepts "some" amount in the Discovery Room. Given that most children used communication and observation during their visit, this is accurate. Most children did not display usage of all the science process skills while exploring the Discovery Room, but the majority used at least two and sometimes three or four. Therefore, the parental response that children explored scientific concepts "some" during their visit is accurate.

In the responses, three parents indicated that their child did not interact with the Wind Tunnel, while 12 parents indicated their child did interact with the Wind Tunnel. The questions about the Wind Tunnel were about using senses at the Wind Tunnel and how the graphics affected the visit. Figure 11 illustrates the parental responses to the question "When visiting the Wind Tunnel, I saw my child use at least one of their five senses as they explored objects in the Wind Tunnel."

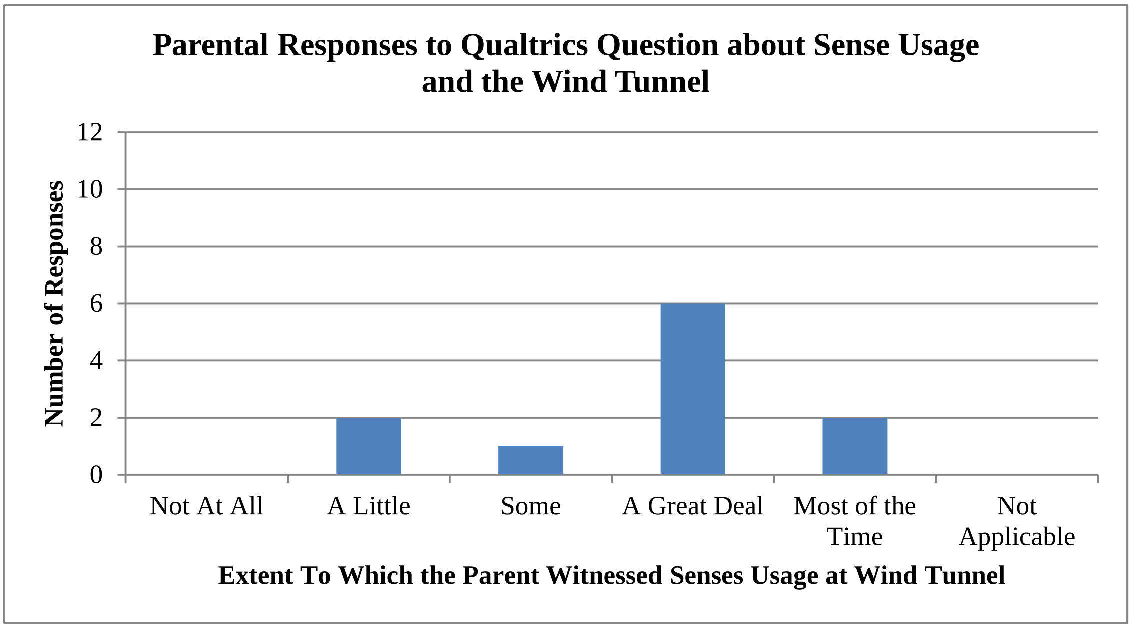


Figure 11. Parental Responses to Qualtrics Online Survey Wind Tunnel Question, (*N*=12).

When parents responded that their child used their senses "A Great Deal" at the Wind Tunnel, they were implying that their child was either observing (sense of sight, touch or hearing) or communicating (sense of sight or hearing). We can only hope that their child was not using their sense of taste at the Wind Tunnel! The response that parents gave—that their child was using at least one of their five senses a great deal of the time while at the wind tunnel—correlates with the amount of communication and observation science process skill usage recorded on the Data Observation Sheets. Yet again, the data collected from parents correlates with the data collected by the observers, meaning the data should be more accurate.

In total, the data collected from the Discovery Room showed three distinctive patterns. One such pattern was that children used the basic science process skills of communication and observation while interacting with objects in the Discovery Room. Another pattern was that the Wind Tunnel was the most popular station in the Discovery Room, as indicated by the amount of time spent by children at that station. Lastly, the usage of signage in the Discovery Room had little to no effect on the interactions that children had with stations in the room.

INTERPRETATION AND CONCLUSION

The first result that came out of data analysis was that the science process skills used most were observation and communication. The science process skill used the least was inference. In my research, I set out to figure out "to what extent do children use science process skills in FLMNH's Discovery Room?" The first trend I noticed while analyzing data shows that children communicate almost constantly in the Discovery Room. All of the science process skills essentially require communication: in order to explain a prediction or state an observation, one must use words. Therefore, communication is a baseline skill that provides a building block for other skills. Most of the time, a child only built the first block as seen by the few times inference was used in the Discovery Room.

Inference is a higher-level skill because it requires a child to think and then explain why an object acts the way it does. Sometimes, children offer these explanations willingly, but often, they need to be prompted to explain their thinking. This could reflect a lack of parental interaction or at least a different focus when interacting with objects in the room.

An additional explanation for the rarity of prediction recorded in the Discovery Room is that children were silently making predictions about the outcome of events. A child could be observed placing pieces of fabric into the Wind Tunnel, then placing a basket in the Wind Tunnel, but remained silent during this process. That child might have been thinking, “This basket is heavier than the fabric, I don’t think it will fly,” while at the Wind Tunnel, but the observer could not know that because the thought was not communicated.

Another science process skill, inference, was used infrequently in the Discovery Room. In the examples of inference, we see that most of them take place at the Wind Tunnel. This is because the Wind Tunnel allows visitors to witness an action—the air blowing objects upward. Visitors are then able to infer what will happen if they put various objects into the Wind Tunnel: the objects will fly upward. At other stations, such as the Blocks and the Gears, there is no dynamic interaction. Visitors can freely construct towers or buildings out of blocks, but there is no impetus that entices them to build such items. The graphics designed for the Blocks station were designed to provide this impetus, but no observations recorded children using the blocks graphics as construction models.

At the Wind Tunnel, there is an immediate chance to see what happens when you put another object in the tunnel. For example, a preschool-aged visitor saw that a strawberry basket flew upwards out of the Wind Tunnel. Then, the visitor stuck feathers into the sides of the basket and put the basket in the Wind Tunnel. The basket no longer flew, so the visitor removed the feathers and put the basket back in the Wind Tunnel. The implied inference is that the feathers made the basket too heavy to fly. The visitor then predicted that the basket would fly again if they removed the feathers. Visitors were always intrigued or gleeful when exploring the Wind Tunnel station. The novel interaction and similar interactions were a large reason why the Wind Tunnel was one of the most visited stations in the Discovery Room.

Although the Discovery Room is in a science museum, the room often becomes a relief for parents and a playroom for the children. In the Parent Interviews data collection instrument, parents were asked "Do you try to support your child's learning when you visit the Discovery Room or do you feel this is a time for your child to explore on his own or with other children?" Distribution between responses was evenly split. In 36 Parent Interviews that were attached to the Data Observation Sheets, eight parents indicated that they supported their child's learning in the Discovery Room, while six parents indicated that they let their child explore on their own. Seven parents answered that they allowed both avenues of exploration in the Discovery Room. Fifteen parents, however, were not asked this question because the parent declined the Parent Interview due to time constraints.

There was no correlation between a parent supporting a child's learning and the usage of higher-level science process skills. I only recorded one instance of a parent responding that they support their child's exploration in the Discovery Room and the child's usage of the science process skills of prediction and inference.

A preschool-aged boy was exploring the room with his father. The father was very involved in his child's exploration. The boy dictated where in the room they explored, but the father willingly followed and explored with the child. When they arrived at the Blocks station, the father sat down on the floor with the boy and began to help the child build a ramp. When they finished making their ramp, the father and son proceeded to roll cylindrical blocks down the ramp. The boy exclaimed “This ramp will make it go fast,” right before launching a small, cylindrical block off the top of the ramp.

This was the only instance of prediction that occurred when a parent responded to the Parent Interview and was observed using the Data Observation Sheet. Although there may be more examples of parents helping build science process skills through supporting their child’s learning in the Discovery Room, all other instances of parents exclaiming that they support their child’s learning featured the science process skills of communication and observation.

The next trend data analysis revealed was that of the most frequently visited stations in the Discovery Room. Research found that the most frequented stations were the Dig Box, the Wind Tunnel, and the Puzzles and Games. These results answered the research question “which stations or objects entice children the most?”

The Wind Tunnel was enticing when there were already other children present and using the station. In multiple observations, a child would be at the Wind Tunnel and experimenting with the materials. A child would enter the room and their attention was immediately on the objects floating in the Wind Tunnel. In one observation, I wrote, “this child beelined for the Wind Tunnel when they entered the room.” In this observation, there were visitors in the room, and some were using the Wind Tunnel. The ongoing interaction at the Wind Tunnel intrigued the child I was observing, as indicated by their body language, eye contact, and movement towards the Wind Tunnel. That child then also began to interact with the Wind Tunnel. This was not an isolated incident. In many observations, I recorded that a child immediately interacted with the Wind Tunnel if the station was already in use.

There is something to be said about the placement of the stations. The first possibility is due to the proximity of these exhibits to the entrance of the exhibit. Figure 12 is a rough diagram of the stations layout.

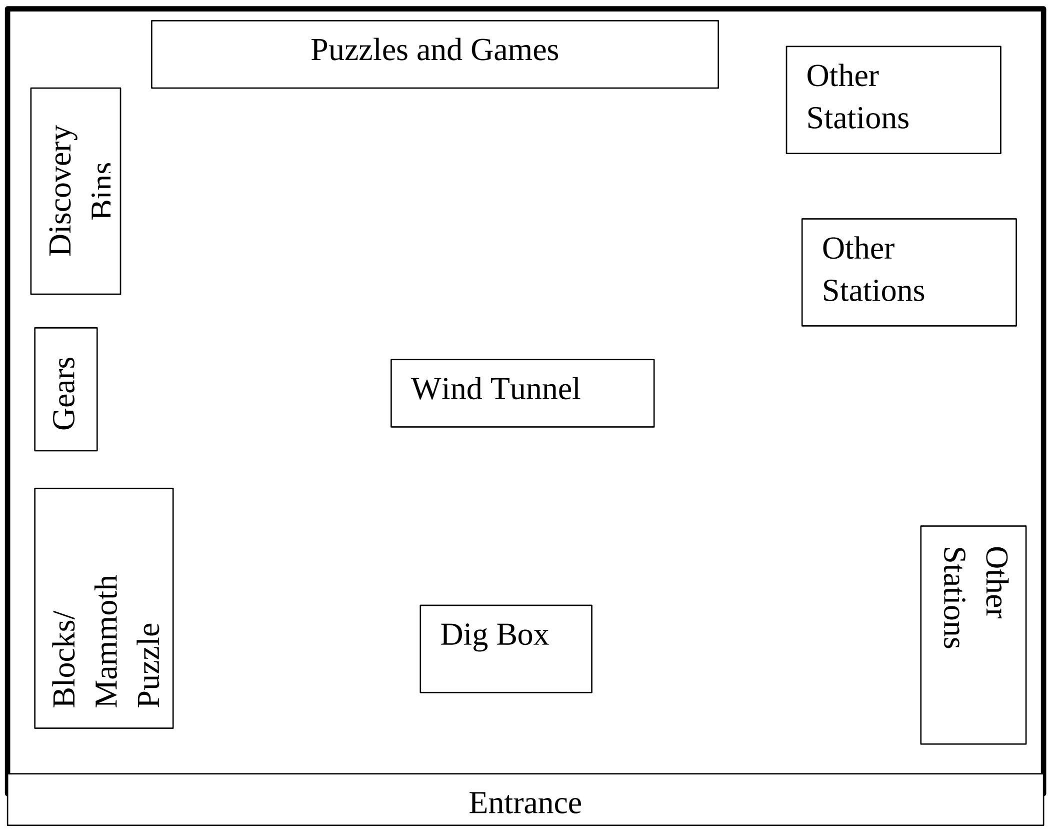


Figure 12. Discovery Room Layout.

The Dig Box is situated at the front of the exhibit, which could explain why there is a higher frequency of visitation to this station. However, the Blocks/Mammoth Puzzle and another station (the “Treehouse”) are also at the front of the exhibit, but display less frequent visitation. The explanation of convenience could support the high frequency of visits: the Dig Box is literally right in front of the visitors, so they might as well go see what treasures it holds.

The Dig Box could have experienced higher visitation than the Wind Tunnel in certain circumstances: the Wind Tunnel was removed for repairs during two Sundays that observations were collected. When this happened, more children flocked to the Dig Box than any other station that was visited on those Sunday.

The Wind Tunnel's high visitation can be explained by the novelty of the station. More often than not, children are already at the Wind Tunnel and objects are flying and falling at a regular rate. This phenomenon is exciting to visitors who are intrigued and want to try to make objects fly. Therefore, the frequency of visits the Wind Tunnel can be explained by the dynamic nature of this station.

The Dig Box is situated so that visitors have to walk past it to get to any other station in the exhibit. This placement could be responsible for the high rate of visitation. An experiment could be done if one of the less frequented stations, such as the Discovery Bins, were to switch places with the Dig Box. However, the Dig Box is fairly permanently placed, and it would be a very complicated process to switch it to a different location in the Discovery Room. The question remains: would the Dig Box still receive a high rate of visitation? If so, the placement would not be the reason the Dig Box is so popular.

The third most frequently visited station is the Puzzles and Games. These are placed on shelves in bins at the back of the Discovery Room; therefore accessibility probably does not affect the usage frequency of this station. The frequency of visits could be explained by the amount of objects included in this station. There are wooden puzzles, floor puzzles, magnetic games, alphabet blocks, and other interactive toys. The extensive variety of activities that can be done at this station could be a reason it is frequented so often. Familiarity with the station is another reason that children might choose to explore the station. Different stations, such as the Blocks/Mammoth Puzzle and the Gears station only feature one object: wooden blocks or plastic gears. These stations did not have the high visitation, or holding time, of the Puzzles and Games station. Field Notes from observations show a child who spent a very limited amount of time at the Gears and "seemed bored" because he would pick up a piece, throw it back in the box, then look around the room. When this child visited the Puzzles and Games, he engaged with the objects in the station in a similar manner to the Gears, but did so for a longer time because there were more objects to explore.

There is also a floor mat directly in front of the Puzzles and Games station on which children can bring out any object to explore. This floor mat is a partial component to the station's success. In the pilot study completed in the room in 2012, the mat was not yet installed and the usage of the Puzzles and Games station was not as frequent. During this study, when the mat was installed, the Puzzles and Games station featured more visitation than the pilot study. Further exploration of objects, which enhance skills such as prediction and inference, could be researched to make the station even more successful.

Another trend explored in the graphs and with data analysis was that of time spent at stations. Like the data trend of most frequented station, visitors stayed the longest at the Wind Tunnel and the Puzzles and Games. The Puzzles and Games were used for two hours and three minutes in the total observation time of nine hours and 58 minutes. The Wind Tunnel was only used for a bit longer, at two hours and 34 minutes of usage in the study time. This shows that these stations are well used and well liked. In researching time spent, I was exploring the question, “what is the average length of time spent in the Discovery Room?” The most visited stations do not showcase the average length of time spent visited, rather, they show the time spent at stations. This is just as important because it can tell museum personnel about the stations that are valuable and enticing to visitors.

As shown in the data, visitors spent more time at the Puzzles and Games and the Wind Tunnel. Parents who completed the Parent Interview most often said that the station they thought their child spent the most time at was the Wind Tunnel. When asked why, one parent responded that their child could use the Wind Tunnel to explore a multitude of objects and make them move in different directions, implying that the dynamic nature of the wind tunnel and active manipulation of objects led to more time spent at a station. The dynamic nature of the Wind Tunnel can explain the frequency and the length of visits to this station. Many visitors commented positively about the Wind Tunnel with statements of awe such as, “that’s amazing!” and “wow!” Descriptions of children laughing in glee and excitement when they put an object in the Wind Tunnel were included in nearly every observation, which included the Wind Tunnel. This station witnesses a high rate of visitation and science process skills because of its dynamic nature.

Although the Puzzles and Games were, on average, visited the second most frequently, parents did not respond accordingly in the Parent Interviews. One of the parents even responded that the only reason her child visited the Puzzles and Games station was because the Wind Tunnel was broken. She said, “He misses the wind tunnel. Today he liked the magnets the most.” The magnets are a component of the Puzzles and

Games station, but this parent thought that her child would have played more with the Wind Tunnel had it been present. The conclusion that can be made from the data collected concerning average time spent in the Discovery Room is that children spend a lot of time at the Wind Tunnel. Additionally, parents noticed the time their children spent at the Wind Tunnel. Although data showed that visitors also spent a lot of time at the Puzzles and Games, parents did not imply on the Parent Interviews that their children frequented the Puzzles and Games.

Further research could be conducted into the amount of objects a station offers a visitor and the interest value of the station. In the case of the Puzzles and Games, visitors might have spent a lot of time at this station because there were many different objects to explore. These objects were freely accessible. Children could be selective in choosing what they wished to interact with, interact with that object then move on to another object within the same realm. The Discovery Bins also employ a variety of objects to explore. There are six bins which contain plastic figurines, bottles filled with mysterious liquids of differing densities, and a vest to put on to explore anatomy. Surely the Discovery Bins offer the same value and amount of objects to explore as the Puzzles and Games! Additional research could be done if the Discovery Bins were set out at the beginning of an observation and kept out the whole day. Would this entice children to play with them more?

This action research project sought to answer the question “To what extent do children use science process skills in the Florida Museum of Natural History’s Discovery Room?” Children use science process skills most of the time when they are exploring the Discovery Room. However, the skills that children use are not the highest level of science process skills, such as inference and prediction. Instead, children are using the basics: observation and communication. These are extremely valuable skills to have as they can lead to utterances of prediction and inference.

Another question that this action research project sought to answer was “In what ways will increased graphics or directions affect the length of visits/the usage of science process skills?” This study found that graphics have little to no effect on the usage of science process skills in the Discovery Room. While conducting preliminary research into graphics, Atkins’ (2009) study featuring the heat camera exhibit proved helpful but also ended up being contrary to my experiences. Discovery Room visitors either did not notice the signs I had created or ignored them. In Atkins’ study, visitors would completely focus on the labeling/signage, then complete an activity suggested by the labels, and leave the exhibit.

This phenomenon absolutely did not occur in the Discovery Room. Although there was very little writing and mostly graphics on the signs, children did not pursue the designs depicted on the Blocks sign or the Wind Tunnel sign. The Discovery Room also features a large assortment of objects. In Atkins’ study, the heat camera was the only object in the room. In this regard, families would focus their attention entirely on the heat camera. This research in FLMNH’s Discovery Room is quite different from the results that were collected from another museum signage study discussed in the Conceptual Framework section of this paper. The research Atkins (2009) conducted in the heat camera exhibit indicated that when visitors are given a task via signage, the visitor would work to complete that task then leave the exhibit. This was not seen in the Discovery Room. Almost all visitors ignored the signage. Atkins studied adults and older children, while the Discovery Room visitors consisted of young children. However, parents accompanied the young children. When the parents explored the exhibit with their child, all parents except one did not engage with the signage. In the Discovery Room, if a child did not wish to explore a particular station like the Blocks, they simply did not.

What does this research mean for science museums that insist that signage is necessary for visitors to understand their exhibits? Museums can spend money on the signage, but visitors may not engage with the signage, especially if the signage is attempting to engage a younger audience. One could argue that if you continue to keep signage in museums, children can be taught to explore the signage through mimicking their parents. Museums are, after all, spaces for cognitive development. However, the research I completed showed that neither parents nor children paid much attention to signage in the Discovery Room.

In generalizing the information gathered from this action research project, it could be said that the more dynamic and interactive an exhibit is for a child, the more science process skill usage there will be. The Wind Tunnel is a dynamic component to the Discovery Room and it is one of the most visited stations in the room. If other museums want their young visitors to engage in ways of doing science, it would be beneficial to include a station like the Wind Tunnel.

Currently, the Discovery Room features a less dynamic, but popular station: the Blocks/Mammoth Puzzle. If there was a way to make this station more intriguing and dynamic, perhaps more children would engage with it. The “Rolling Rolling Rolling” exhibit from the Science Center NEMO featured wooden cylinders. In that study, the “Rolling Rolling Rolling” exhibit drew more active manipulation of objects than the other exhibit. If the FLMNH set up a Blocks station which had pre-made features, like ramps, children might more actively engage with the blocks and use the science process skills of inference and prediction. If designers of the exhibit want free play to occur with blocks, there is still a place for that. However, if higher level science process skills want to be seen in the Discovery Room, a different set up is necessary at the Blocks/Mammoth Puzzle or similar station in the new Discovery Room.

The data and conclusions of this Discovery Room action research projects will be presented to the museum professionals who are creating the new Discovery Room, on which construction will begin in 2015. The information must be presented so that the Discovery Room can continue on a successful path of educating our visitors about the world around them. Science process skill usage is integral in a child's development and we need to ensure that a new Discovery Room allows children to hone their abilities. So far, the plans do not include a dynamic station like the Wind Tunnel. I would strongly suggest that they include a wind tunnel or a similar station.

In essence, this project showed that children engage with objects in the Florida Museum of Natural History's Discovery Room in a scientifically meaningful way through their almost constant usage of communication and observation. However, research also suggests that young visitors should expand their horizons further in exploring scientific concepts through the usage of science process skills like prediction and inference. Communication and observation are building blocks to prediction and inference. The Discovery Room and exhibits like it need to engage children more fully in order to see higher-level science process skills.

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APPENDICES

APPENDIX A

DATA OBSERVATION SHEET

Observation Date:	Appx. Child Age:	Description of Family Group:

Station	Time at Station	Science Process Skill Used	Description of Child's Activity	SPS Descriptions
Wind Tunnel		1 2 3 4 5 6		1. Observation: Using the 5 senses to make qualitative or quantitative statements about the station and its
Blocks/Mammoth Puzzle		1 2 3 4 5 6		2. Communication: Using words or gestures to describe experiences at the station
Discovery Bins		1 2 3 4 5 6		3. Classification: Sorting objects at the station into groups (serial ordering, binary classification, or multistage classification) based on observations
Dig Box		1 2 3 4 5 6		4. Measurement: A 2-part statement consisting of a number defining "how much" or "how many" and a name for the measuring unit. E.g. "My shoe is 3 blocks long"
Gears		1 2 3 4 5 6		5. Inference: An explanation or interpretation of an object's behavior based on observations. E.g. The fabric-filled basket is sitting at the bottom of the wind tunnel because it's too heavy to
Puzzles and Games		1 2 3 4 5 6		6. Prediction: An educated guess is made about the outcome of a future event. E.g. If I take out some fabric, the basket will fly high.
Other Stations		1 2 3 4 5 6		

Observer Initials:	Total Time Spent:	Room #s Pre-Observ.	Children:	Adults:	Room #s Post-	Children:	Adults:

APPENDIX B

QUALTRICS SURVEY

Children and families visit the Florida Museum of Natural History's Discovery Room on a daily basis, yet we know little about children's abilities to apply scientific concepts to their experiences in the Discovery Room. Responses to this survey will help us understand children's experiences and allow us to develop a richer, science-based Discovery Room at the Florida Museum of Natural History.

This survey should take 5-10 minutes to complete.

By completing this survey, you are giving consent for Lisa Lundgren to use your responses. Your participation is voluntary. There are no direct benefits or risks to you for participating, and no compensation. You may quit at any time or skip any item. You may withdraw your consent to participate at any time without penalty. If you respond via email, your IP address will be registered; however, your responses will remain anonymous. Thank you for your help.

If you have questions about this survey, contact Lisa Lundgren, Florida Museum of Natural History; University of Florida Education Department; Montana State University Science Education Department, 303-524-4203, lisa.lundgren21@gmail.com. If you want more information about your rights as a research participant, contact the Montana State University IRB Office, 406-994-6783, mquinn@montana.edu.

By checking the box below I acknowledge that I have read the information and agree to participate in this survey. If you do not wish to participate, please close your browser at this time.

● I Agree

Please indicate the extent to which your child explored scientific concepts such as air movement, gravity, and paleontology while visiting the Discovery Room.

Not At All	A Little	Some	A Great Deal	Most of the Time	Not Applicable
●	●	●	●	●	●

Did your child interact with the wind tunnel?

● Yes

● No

While visiting the wind tunnel, I saw my child use at least one of their five senses as they explored the objects in the wind tunnel

Not At All	A Little	Some	A Great Deal	Most of the Time	Not Applicable
●	●	●	●	●	●

The signs depicting different ways to build objects were beneficial to my child's experience at the wind tunnel.

Not At All	A Little	Some	A Great Deal	Most of the Time	Not Applicable
●	●	●	●	●	●

Did your child interact with the blocks?

● Yes

● No

While interacting with the blocks, my child communicated with me or other visitors about what they were doing.

Not At All	A Little	Some	A Great Deal	Most of the Time	Not Applicable
●	●	●	●	●	●

The signs depicting various block buildings were used by my child when playing with blocks.

● Yes

● No

● I'm Not Sure

Did your child interact with the Discovery Bins?

● Yes

● No

When playing with the “Discovery Bins” (e.g the Prehistoric Creatures box, the Anatomy box, the Florida Wildlife box), I saw my child sorting the objects into categories by color, type of animal, size, or shape, etc.

Not At All	A Little	Some	A Great Deal	Most of the Time	Not Applicable
●	●	●	●	●	●

Did your child interact with the paleontology dig box?

● Yes

- No

When using the paleontology dig box, I saw my child use at least one of their five senses to make observations about objects in the dig box.

Not At All	A Little	Some	A Great Deal	Most of the Time	Not Applicable
●	●	●	●	●	●

Which of the following best describes the way you support your child's play in the Discovery Room?

- I let my child engage in free play.
- I guide the way my child interacts in the Discovery Room.
- I actively support and structure the activities for my child in the Discovery Room.

I think that most parents in the Discovery Room believe...

- that children learn best through independent exploration.
- that children learn best when parents structure the activities in the Discovery Room.
- that children learn best through a mix of independent exploration and structured, parent-guided activites.

Thank you for your responses. We appreciate your feedback! Do you have any additional comments about the Discovery Room?

APPENDIX C

PARENT INTERVIEW

By completing this survey you are giving consent for Lisa Lundgren to use your responses. Your participation is voluntary. There are no direct risks or benefits to you for participating, and no compensation. You may quit at any time or skip any item. You may withdraw your consent at any time without penalty.

Demographics:

Age Group **With which ethnicity do you identify?**

Check all that apply. **Ethnicity**

- ○ 18-26
- ○ 26-40
- ○ 40-55
- ○ 55-Older

- ○ American Indian or Alaska Native
- ○ Asian
- ○ Black or African American
- ○ Native Hawaiian or Pacific Islander
- ○ White
- ○ Other (Please Specify) ___________

- ○ Hispanic or Latino
- ○ Non-Hispanic

1. Have you visited the Florida Museum of Natural History and the Discovery Room previously?

____

____

2. In what area do you think your child spent the most time?

____

____

3. Which objects did your child enjoy the most?

____

____

4. Did you see your child using science knowledge or skills when interacting with objects in the Discovery Room?

____

____

5. Do you try to support your child's learning when you visit the Discovery Room or do you feel this is a time for your child to explore on his own or with other children?

____

____

6. Do you have any suggestions for improvements or changes to the Florida Museum of Natural History's Discovery Room?

____

____

APPENDIX D

IRB EXEMPTION SHEET

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

MONTANA STATE UNIVERSITY

960 Technology Blvd. Room 127
c/o Immunology & Infectious Diseases
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
FAX: 406-994-4303
E-mail: cherylj@montana.edu

Chair: Mark Quinn
406-994-5721
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-6783
cherylj@montana.edu

MEMORANDUM

TO: Lisa Lundgren and Walt Woolbaugh

FROM: Mark Quinn, Chair *Mark Quinn CJ*

DATE: November 25, 2013

RE: *"Exploring How Children Use Science Process Skills in a Museum Setting"* [LL112513-EX]

The above research, described in your submission of November 25, 2013, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

___ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

___ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

___ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

___ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.