Impact Planning, Evaluation & Audience Research

Randi Korn & Associates, Inc.
118 East Del Ray Avenue
Alexandria, VA 22301

Summative Evaluation:
Mammoth Discovery!

Prepared for the
Children's Discovery Museum
San Jose, CA

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INTRODUCTION

Children's Discovery Museum of San Jose (CDM) contracted Randi Korn & Associates, Inc. (RK&A) to conduct a summative evaluation of the *Mammoth Discovery!* exhibition, one part of a comprehensive project funded by the National Science Foundation (NSF). The project included four components: 1) a State of the Profession Study of museum professionals' experiences creating science learning experiences for children;[1] 2) a series of professional development workshops for a cohort of children's museum professionals (called a Community of Learners) designed to support children's museums partnering with universities to conduct research[2]; 3) research on children's understanding of evidence (conducted by Maureen Callanan); and 4) an exhibition, *Mammoth Discovery!*, that was designed to foster evidence-based reasoning among children 4 to 10 years of age and their caregivers. This report describes the extent to which the exhibition achieved its intended impact on visiting families with 4 to 10 year-old children. The following summary and discussion highlights key findings from the project, describes the achievement of the intended impacts, identifies what may have helped or hindered CDM from achieving intended results, and provides recommendations to CDM and the field as whole based on the evaluation.

Selected highlights of the study are included in this summary and discussion. Please consult the body of the report for a detailed description of the methodology and account of the findings.

EXHIBITION CONTEXT

As described on CDM's Web site (2012), *Mammoth Discovery!* is a 2,200 square foot exhibition that features the story of Lupe, fossilized mammoth bones found in San Jose. The exhibition includes a full-size replica of Lupe and Lupe's actual skull, femur, and pelvis fossils. Moreover, the exhibition engages children and adults in the scientific process through hands-on exhibits that prompt children and adults to dig for bones, dissect evidence, and compare fossils, among other things. The exhibition is tri-lingual, containing labeling in English, Spanish, and Vietnamese, and addresses the three themes of CDM's educational mission: community, connections, and creativity.

METHODOLOGY

RK&A selected two methodologies, timing and tracking observations and in-depth interviews, to capture visitors' experiences in *Mammoth Discovery!* and examine the impact this exhibition has on visitor groups (see Table i). Timing and tracking observations provide a quantitative account of how visitors behave in exhibitions and react to exhibition components. Observations indicate how much time

[1] See Randi Korn & Associates, Inc., *State-of-the-Profession Study: Science in Children's Mus*eums, 2009
[2] See Randi Korn & Associates, Inc., *Community of Learners Impact Study: Mammoth Discovery!*, 2011

visitors spend in an exhibition and at individual components as well as identify a range of visitor behaviors. RK&A conducted in-depth, open-ended interviews with CDM visitors in multigenerational groups (one adult and one child 4-10 years old) who had visited the *Mammoth Discovery!* exhibition (treatment group) and multigenerational groups who had not seen the exhibition (control group). Interview data were analyzed qualitatively and quantitatively. For the quantitative analysis, a scoring rubric was used to analyze and compare results between treatment and control groups to determine the impact of the exhibition.

TABLE i

METHODOLOGICAL OVERVIEW

METHODOLOGY	ANALYSIS	SAMPLE
Timing and Tracking Observations	Quantitative	111 observations of children 4 to 10 years old in the *Mammoth Discovery!*
In-depth interviews	Qualitative	84 interviews with multigenerational groups that included one adult and one child 4 to 10 years old after visiting *Mammoth Discovery!*
	Quantitative	178 interviews with multigenerational groups that included one adult and one child 4 to 10 years old; 94 groups were interviewed before visiting *Mammoth Discovery!* (control) and 84 groups were interviewed after visiting *Mammoth Discovery!* (treatment)

KEY FINDINGS

In this section, we present key findings to put the exhibition in context of other exhibitions and provide context for the discussion of achievement of the intended impacts.

TIMING AND TRACKING OBSERVATIONS

Children's time spent in *Mammoth Discovery!* is typical of time spent in other children's museums' exhibitions (RK&A, 2010; RK&A, 2008; RK&A, 2004).[3] Children's total time in *Mammoth Discovery!* ranged from 40 seconds to 40 minutes, 48 seconds., and the median time in the exhibition was 7 minutes, 53 seconds. Children spent the most time at the interactives "23. Mammoth Puzzle" (median time = 4 minutes 40 seconds) and "26. Imagine the Past/Shadow Puppets" (median time = 2 minutes 44 seconds). By contrast, children spent the least time at the interactive "22. Solve Mysteries (unknown skeleton)" (median time = 9 seconds) and the exhibit "1. Who Found these Fossils? (entry movie)" (median time = 6 seconds), which provided interpretive support.

Additionally, the exhibition was as thoroughly used (number of exhibit stops) as other children's museum exhibitions (RK&A, 2008; RK&A, 2004). Children stopped at between one and twenty of the identified exhibit stops, and the median number of exhibits stopped at was six. The most popular exhibits were the interactives "8. Look for Tiny Clues (dig pit)" (52 percent of the observed children stopped) and "26. Imagine the Past/Shadow Puppets" (50 percent of the observed children stopped). Again, as is typical, the least popular exhibits were the non-interactives "Mammoth News

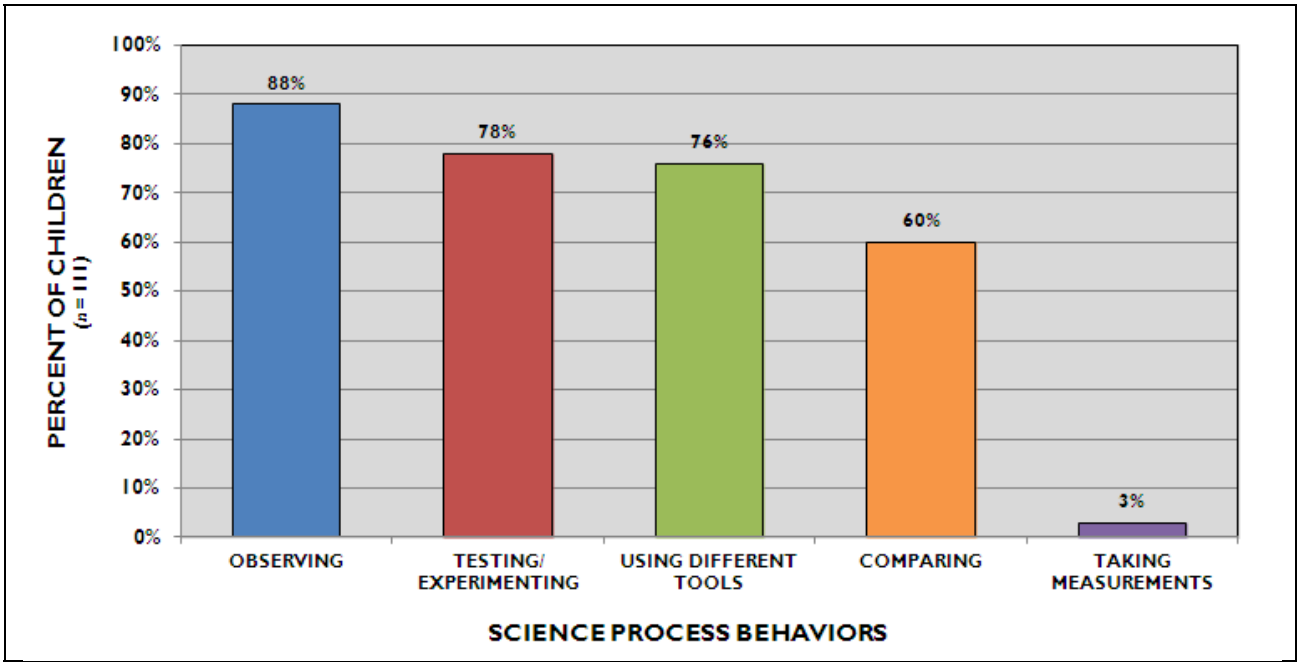
[3] RK&A observed children of similar age for all of these exhibitions.

(couch)" (1 percent of the observed children stopped) and "Where Were These Fossils Discovered?" (map) (3 percent of observed children).

Observed children engaged in many science process skills in the exhibition (see Figure i). Most children demonstrated the science process skill of observing (88 percent), and many were testing/experimenting (78 percent), using different tools (76 percent), and comparing (60 percent). Taking measurements was the least observed science process skill, although it was also a behavior applicable to the fewest exhibits, whereas the other behaviors could be observed at multiple exhibits.

FIGURE i

SUMMARY OF SCIENCE PROCESS SKILL BEHAVIORS IN THE EXHIBITION



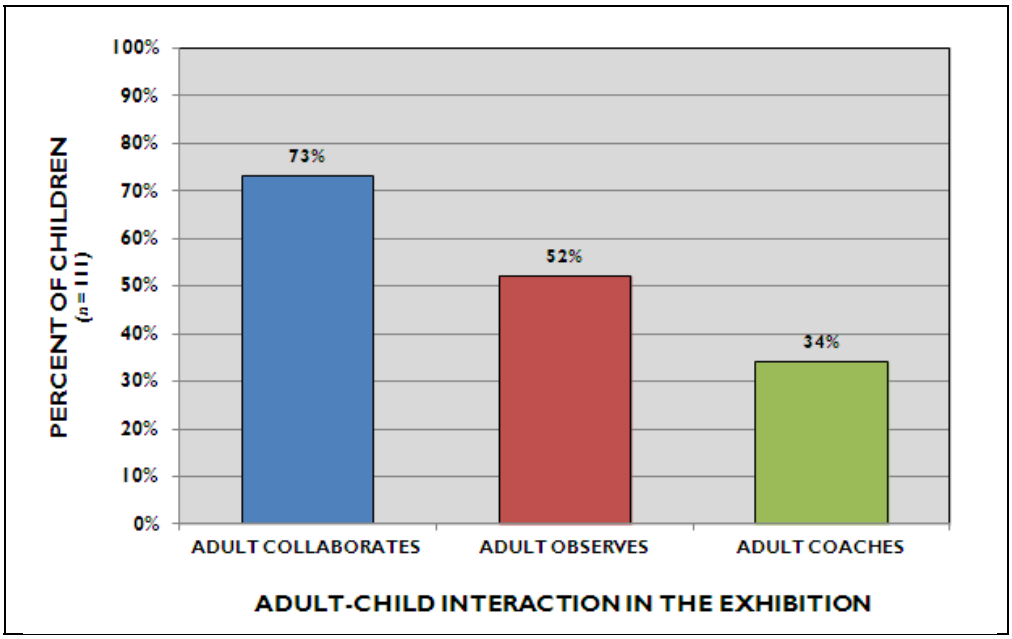
Adult-child interaction took many forms, but was high overall (see Figure ii). In this study, collaboration is the highest level of adult-child interaction. Findings showed that 73 percent of adults collaborated with their child in the exhibition. In other studies, RK&A has evaluated adult-child interaction through various lens based on a particular Museum's interest. For instance, in the evaluation of *Cyberchase!* for the Children's Museum of Houston, RK&A only looked at coaching behaviors (61 percent). By contrast at the Please Touch Museum and Chicago Children's Museum we looked at several specific adult-child interactions. At the Please Touch Museum, we documented the percentage of observations in which adults provide their child with information or instruction (39 percent), play with their child (37 percent), model how to use an exhibit (35 percent), and provide physical assistance to their child (31 percent) among other things[4] (RK&A, 2010). At the Chicago Children's Museum, we asked data collectors to classify adult-child interaction overall by selecting one behavior that best describes the overall adult-child interaction, in which case adults worked collaboratively with children in a particular exhibit in 40 percent of observations (RK&A, 2008b). While the various methods employed and types of adult-child interactions observed prevents us from making direct comparisons between this

[4] More than one adult-child interaction can be counted per observation.

study's findings and others, loose comparisons suggest that the adult-child interaction in *Mammoth Discovery!* are relatively high.

FIGURE ii

SUMMARY OF ADULT-CHILD INTERACTION IN THE EXHIBITION



IN-DEPTH INTERVIEWS: QUALITATIVE ANALYSIS

Most interviewees responded positively about the exhibition and their experience. About one-quarter of interviewees liked that many of the exhibits were interactive and that they had opportunities to touch the bones and do hands-on activities. One-quarter of interviewees liked that the exhibition was informative or educational; some of these interviewees appreciated the opportunity to learn about scientific processes specifically. Several interviewees liked that the exhibition showed what scientists do. Some described the whole exhibition as "fun."

About two-thirds of interviewees learned something about mammoths and mammoth biology in the exhibition. For instance, when asked what the exhibition is about, one adult female said: "The study of mammoths and when they lived, and when, where were they discovered, and what else, and how big they are and what they look like. What the bones look like."

Two-thirds understood that mammoths used to live in the San Jose area or that mammoth bones were discovered there. For instance, one adult said, "We're not from here, and it showed where the mammoth was found. I didn't know it was a mammoth from the area. On the wall, it's like oh we found this by the airport so it's like oh okay, I didn't realize that, I just thought you had a mammoth exhibit because you are a children's museum. So that was really cool that it is something from your area so that was really nice because it's something local because you know kids read about dinosaurs and things in books but to find something locally is really cool. It's like hey this is a mammoth from up the road."

Two-thirds of interviewees took away ideas about scientific thinking and the scientific process. For instance, when asked what they thought the exhibition was about, several interviewees said that the exhibition was not just about mammoths, but about scientific processes (unprompted). When asked

specifically about what they learned about science through the exhibition, about two-thirds of interviewees gave a specific scientific, but the majority talking about scientific thinking and the scientific process. For instance, when asked what she learned, one child said about one-half of visitors said they learned about what scientists do. Some interviewees said "More about what scientists do and brushing off and making seeing better." The adult added, "Yeah it gave them a real experience of seeing how scientists go about studying artifacts."

IN-DEPTH INTERVIEWS: QUANTITATIVE ANALYSIS

Key findings from the quantitative analysis of in-depth interviews are all related to the intended impacts, and thus, are presented and discussed below.

ACHIEVEMENT OF INTENDED IMPACTS

Achievement of the intended impacts is summarized in Table iii. The discussion below is dedicated to describing the achievement of the impacts through the various data collected. In the discussion, RK&A will identify data that demonstrates achievement of the intended impacts, describe CDM's actions that supported these impacts, and discuss challenges in achieving the intended impacts.

TABLE ii

ACHIEVEMENT OF INTENDED IMPACTS

IMPACT	ACHIEVEMENT
Impact 1: Children and their caregivers will engage in scientific thinking (i.e., science as a creative process).	Yes
Impact 2: Children and their caregivers will become aware that they can and are engaging in a process similar to that in which scientists engage.	Somewhat
Impact 3: Children and their caregivers will learn about mammoths and their habitats and will understand that knowledge about mammoths is based on evidence.	Somewhat
Impact 4: Caregivers will support children's learning through collaborative exploration.	Yes

IMPACT 1

Impact 1 states, "Children and their caregivers will engage in scientific thinking (i.e., science as a creative process)." Encouragingly, most children and caregivers who visited *Mammoth Discovery!* described engaging in at least one scientific activity or process skill in the exhibition, and the majority of children and caregivers described two or more science activities or process skills. For instance, visitors talked about digging for bones, cleaning them, and comparing them to other animals' or their own bones; they also described using a microscope to look at the rings of a tusk. For example, when asked what the exhibition was about, one group said:

> Child: About fossils and mammoth fossils and what scientists do to recreate them and how fossils are preserved. I also like that thing you can turn and you can see uncovering the fossil, finding a fossil, recovering a fossil. Adult: The different stages. Child: Yeah, and that kind of showed me what they did to get the fossil out of the ground. They picked it. They dug it. They were very gentle. Adult: . . . . And then a lot of it was about, like he said, how do you go about

> discovering it, the bones, and then how do you figure out, once you get them, that it's a mammoth or that it's old or that it's a male or female—all that kind of stuff. [female 50 and male 11]

Observation data corroborate visitors' self-reported behaviors. The majority of children were observing, testing/experimenting, using different tools, and comparing in the exhibition. The exhibition's design clearly supported engagement in scientific processes and thinking; exhibit components generally focused on one scientific activity or process skill, like at "Dissect Evidence," an exhibit where visitors use a magnifying glass to find evidence of seeds and grass in fossil poop. Furthermore, the concise labels use headings like "Sit and Compare Your Thigh Bone to a Mammoth's" or questions like "What textures do you notice on this bone?" to prompt visitors to engage in scientific thinking.

During the interview that took place as part of the evaluation, however, children and caregivers tended not to demonstrate scientific process and thinking when children and caregivers were presented with an unknown object and prompted to figure out what it might be. For instance, most children or caregivers described the visual and tactile characteristics of the objects, but generally stopped after naming one or two characteristics. Furthermore, while many children and caregivers hypothesized based on evidence, the majority of children and caregivers did so at the "beginning" level of the rubric, meaning that their hypotheses were loosely based on evidence. There were no differences between treatment and control groups in terms of describing or hypothesizing, suggesting that, while children and caregivers engaged scientific thinking skills in *Mammoth Discovery!*, these experiences did not transfer to another situation.

Research shows that it is possible to improve inquiry skills through a one-time experience, like through an exhibition. For instance, Joshua Gutwill and Sue Allen (2009) report improved scientific thinking skills (what they call "inquiry skills") through the Juicy Question activity. However, family group participants in Gutwill and Allen's study included at least one child age 8 to 12 years, and school group participants consisted of fourth to seventh graders—a significantly older age group than those targeted for the *Mammoth Discovery!* evaluation. The age of children targeted for the *Mammoth Discovery!* study is 4 to 10 years, and so transference may not be developmentally appropriate. While the ability to transfer an experience is considered a step towards learning, "learning" scientific thinking skills is not among the four intended impact statements; we explored it given the importance of understanding early learning in museums and in the sciences specifically (Shaffer, 2012).

IMPACT 2

Impact 2, states, "Children and their caregivers will become aware that they can and are engaging in a process similar to that in which scientists engage." This outcome addresses two ideas; we address them separately. First, to explore whether children and their caregivers are aware that they *can* engage in a process similar to that in which scientists engage, RK&A asked the control and treatment groups to describe how their experience identifying an unknown object was similar to and different from what a scientist does. The rubric used to score these responses was affective in nature, gauging children and caregivers' inclinations to find either mostly similarities or mostly differences between their actions and scientists' actions.[5] We found that both control and treatment groups were mostly aware that they can engage in processes similar to scientists. The lack of difference between the two groups indicates that *Mammoth Discovery!* did not move children and caregivers farther along the spectrum of awareness, but the high achievement on this rubric by both groups shows that children and caregivers are inclined to

[5] As noted above, this rubric is affective. Therefore, the scoring was neither based on how many similarities or differences the children and caregivers gave nor the accuracy of the similarities or differences. Rather, the scoring was based on general attitudes revealed through how visitors talked about the similarities and differences between their actions and scientists' actions.

see connections between scientists and themselves, which may provide a leverage point for children's museums when creating science learning programs and exhibits.

The second component of Impact 2 addresses whether *Mammoth Discovery!* visitors acknowledge that, while in the exhibition, they were engaging in a process similar to scientists. We found that more than one-half clearly did so. For example, one visitor group described their experience in the exhibition as follows:

> Child: We went in the sand area. (What did you learn, if anything, from that activity?) Child: More about what scientists do and brushing off and making seeing better. Adult: Yeah it gave them a real experience of seeing how scientists go about studying artifacts. [male 47 and female 6]

This result is relatively encouraging for the informal science learning community, as it demonstrates that carefully designed activities in an exhibition can successfully simulate what scientists do in their work. Children and caregivers responded well to the exhibits and activities, and some said what they liked most about the exhibition was being able to do things that scientists do.

IMPACT 3

Impact 3 states, "Children and their caregivers will learn about mammoths and their habitats and will understand that knowledge about mammoths is based on evidence." As with Impact 2, we address the two parts of this impact separately. First, about two-thirds of children and caregivers left the exhibition having learned about mammoths and their habitats. This result is on par with visitors' comprehension of messages in other children's museum exhibitions (RK&A, 2008a; RK&A, 2004).

The second part of the impact statement is about evidence, and it represents a stretch goal for this project, given the target age group. The majority of children and caregivers did not demonstrate an understanding that knowledge about mammoths is based on evidence. This finding may be discouraging, given CDM's efforts to create explicit exhibit activities and associated explanatory text to demonstrate that knowledge is based on evidence. For instance, some labels directly addressed the connection between evidence and knowledge: "Scientists know that mammoths ate seeds and plants by looking at what was left behind—fossil poop." However, this finding is not that surprising, as connecting evidence with knowledge (e.g., knowing how we know what we know) is difficult and requires high-level thinking. For example, in a study for the Museum of the City of New York, we found that one-half of fourth-graders were able to explain how they know what they know about an object, illustration, or primary source material (RK&A, 2010). Again, age is an important variable. Students in the aforementioned study were older than those who participated in the *Mammoth Discovery!* study.

Furthermore, caregivers are an important component in the achievement of this impact, as they should be since they are the young visitors' companions. While this study showed that caregivers collaborated with their children frequently in the exhibition, as will be discussed in depth later, the *types* of learning supported was not fully explored through this study. However, other research documents that parents sometimes "limit children's access to cognitively complex tasks," like scientific inquiry (National Research Council, 2009, p. 144); that is, parents tend to focus children on the content and experience at singular exhibits, versus helping them learn broad, abstract concepts (National Research Council, 2009).

IMPACT 4

Impact 4 states, "Caregivers will support children's learning through collaborative exploration." As is widely known, the quality of children's experiences in exhibits increases with parent participation

(National Research Council, 2009). *Mammoth Discovery!* exhibits were very successful at promoting collaboration between caregivers and children. RK&A observed nearly three-quarters of caregivers collaborating with their children at one or more exhibits in *Mammoth Discovery!*, and moreover about one-half of caregivers were observed collaborating with their children regularly. This findings is very noteworthy because, by name, and sometimes by design, children's museums exude a child-centric feeling (Downey, Krantz, & Skidmore, 2010; RK&A 2010). However, CDM has shown that careful exhibit design can challenge conceptions that a children's museum is for children only. CDM made conscious design choices to create family-friendly exhibits, such as by ensuring that all benches are wide enough for two. Exhibits like "What Does a Bone's Size Tell Us" seemed particularly good at inciting collaboration.

However, design is not the only factor projecting a child- versus family-friendly image. This exhibit and study suggests that content can also play a significant role. Our observations indicate more collaboration among caregivers and children in the *Mammoth Discovery!* exhibition compared to other children's exhibitions, and we hypothesize that the obvious science-oriented content may be the cause, as other exhibits in children's museums are often play-oriented. We know that parents sometimes struggle to enter in their child's play or collaborate with their child in play-settings (Downey, Krantz, & Skidmore, 2010).[6] This study seems to suggest that caregivers may be more comfortable collaborating with their children in content-rich exhibitions.

Furthermore, in comparing control and treatment caregivers' while identifying an unknown object, more treatment caregivers (those who visited *Mammoth Discovery!*) scaffolded or facilitated their child's learning during this activity; the difference is statistically significant. For instance, one-quarter of caregivers engaged in scaffolding beyond simply asking their child "What is it?" The fact that treatment caregivers were more likely than control caregivers to scaffold in an activity *after* the exhibition is quite notable since behavior change is very hard to affect through an exhibition (RK&A, 2009). Perhaps, the questions that CDM introduced into the labels may have motivated caregivers in just the right way to encourage modeling.

CONCLUSION

The *Mammoth Discovery!* project — which included a State of the Profession Study (RK&A 2010), professional development workshops called Community of Learners (RK&A, 2012) and an exhibition— was an ambitious undertaking, and CDM certainly rose to the occasion. The Community of Learners project was a compelling and beneficial experience for the cohort of museum educators who participated, and the exhibition proved to be an engaging exhibition that mostly achieved CDM's intended impacts. Impact statements 1, 2, and 3 are particularly aspirational, as it is challenging to present sophisticated science ideas in an exhibition medium to young children and their caregivers. It is impressive that the audience engaged in scientific thinking and children and their adult companions were learning together through collaborative exploration. The exhibition design defied the more typical adult behavior in children's museums—watching children explore on their own. Most of all, CDM should be commended for taking on such difficult work and pursuing it uncompromisingly.

[6] As a sidenote, the Dig Pits were less successful at promoting collaboration among caregivers and children although they were designed with adult comfort in mind. Perhaps, that is because this exhibit was interpreted as more "play" than "science" and so parents were reluctant to collaborate.

RECOMMENDATIONS FOR THE FIELD

In this section, RK&A provides some recommendations for practitioners as well as identifies areas ripe for further investigation.

- Question-asking is a valued strategy for scientific investigation and it was utilized well in *Mammoth Discovery!* However, we wonder if adding different, higher-level thinking questions might further improve caregivers' and children's cognitive experiences, particularly as it relates to Impact 3. For example, the *Mammoth Discovery!* exhibition asks, "What do you notice when you look through the microscope?"—a "knowledge" question that prompted visitors to look through the microscope. Potentially, introducing a comprehension question like "How do you know these are molars?" or application questions like, "Where are the other molars?" and "How do you know?" could further scientific thinking in the exhibition.
- RK&A hypothesized that caregivers may have felt more inclined to collaborate with their child in this exhibition because it is content-oriented versus play-oriented. In fact, the one *Mammoth Discover!* exhibit that may appear play-like, the dig pits, was one of the exhibits that promoted little caregiver-child collaboration despite CDM's intent to design dig pits comfortable for caregivers and children to access. Further, research into this idea would provide useful knowledge.

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INTRODUCTION

Children's Discovery Museum of San Jose (CDM) contracted Randi Korn & Associates, Inc. (RK&A) to conduct a summative evaluation of the *Mammoth Discovery!* exhibition, one of three components of a National Science Foundation (NSF)-funded project. The study examines the extent to which the project achieved its intended impact on visiting families with 4 to 10 year old children. The four intended impacts of *Mammoth Discovery!* are:[7]

INTENDED IMPACTS

1. Children and their caregivers will engage in scientific thinking (i.e., science as a creative process).
2. Children and their caregivers will become aware that they can and are engaging in a process similar to that in which scientists engage.
3. Children and their caregivers will learn about mammoths and their habitats and will understand that knowledge about mammoths is based on evidence.
4. Caregivers will support children's learning through collaborative exploration.

This study was purposefully designed to measure the intended impacts and provide supplemental information around these impacts to explain their achievement. As such, the objectives of the study are to examine:

- Families' total time spent and select behaviors in the exhibition and at each exhibit;
- The degree to which families engage in behaviors indicative of scientific thinking within the exhibition (for example, asking questions, observing, comparing);
- The extent to which caregivers demonstrate behaviors indicative of collaborative exploration and learning (for example, modeling scaffolding, encouragement, asking open-ended questions);
- Overall experiences in the exhibition, including most and least engaging aspects;
- Families' engagement in scientific thinking;
- Families' awareness that they can and are engaging in a process similar to that in which scientists engage;
- The extent to which families learn about mammoths and their understanding that knowledge about mammoths is based on evidence;
- Caregivers' support of their children's learning though collaborative exploration.

[7] The intended impacts presented in the NSF proposal were later refined during a Rubrics Workshop facilitated by RK&A. In this report, we present and measure the refined version of the impacts.

METHODOLOGY AND DATA ANALYSIS

RK&A selected two methodologies, timing and tracking observations and in-depth interviews, to capture visitors' experiences in *Mammoth Discovery!* and examine the impact this exhibition has on visitor groups. These methodologies produce quantitative and qualitative data. Below is a detailed description of each methodology and the approach used to analyze resulting data.

TIMING AND TRACKING OBSERVATIONS

Timing and tracking observations provide an objective and quantitative account of how visitors behave in exhibitions and react to exhibition components. Observational data indicate how much time visitors spend in an exhibition and at individual components as well as identify a range of visitor behaviors. They provide useful context that can help explain the exhibition's impact.

METHODOLOGY

RK&A conducted timing and tracking observations between October and November 2011. Children ages 4 to 10 were eligible to be unobtrusively observed in the exhibition. Trained data collectors selected visitors to observe using a continuous random sampling method. In accordance with this method, the data collector imagined a line outside the main entrance to the exhibition and selected the first eligible child[8] to cross this imaginary line for observation.

Once the child entered the exhibition, the data collector started her stopwatch and tracked the selected child through the exhibition (see Appendix A for the observation guide). On the observation guide, the data collector reported the time the observed child began engaging with an exhibit, including time spent observing the exhibit, and the time the child stopped engaging with the exhibit.[9] Exhibits at which a child engages with the exhibit for three seconds or longer are considered "stops." Data collectors also noted select behaviors for the observed child and his/her visit group (e.g., exhibit specific behaviors, science process skills, adult-child interactions) (see Appendices B to D for descriptions of the behaviors). At each exhibit stop, data collectors indicated whether associated behaviors had happened.

When the child completed his or her visit (exiting through either of the two entrances to the exhibition), the data collector documented the total time spent in the exhibition and reported observable background information (e.g., approximate age, number of adults in the child's visit group). Then, the data collector returned to the main entrance to await the next eligible child to cross the imaginary line.

DATA ANALYSIS AND REPORTING

Observation data are quantitative and were analyzed using SPSS 12.0.1 for Windows, a statistical package for personal computers. Analyses include both descriptive and inferential methods. All statistical analyses run are listed in Appendix E. Within the body of the report, only statistically significant findings ($p \leq .01$) are presented.[10] Refer to Appendix F for the raw data.

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[8] Since children were not asked their age, data collectors were trained to assess children's age based on appearance and selected those children that appeared to be within the target range of 4-10 years.

[9] Sometimes visitors leave an exhibit only to return to it later. The evaluator added any multiple stops together to calculate the time spent at an exhibit.

[10] When the level of significance is set to $p = 0.01$, any finding that exists at a probability (p-value) ≤ 0.01 is "significant." When a finding (such as a relationship between two variables) has a p-value of 0.01, there is a 99 percent probability that the finding exists; that is, 99 out of 100 times, the finding is correct. Conversely, there is a 1 percent probability that the finding does not exist; in other words, 1 out of 100 times, the finding appears by chance.

Frequency distributions were calculated for all categorical variables. For ratio-level variables, such as "total time in the exhibition," summary statistics, including the range and median (data point at which half the responses fall above and half fall below), were also calculated.[11]

To examine the relationship between two categorical variables, cross-tabulation tables were computed to show the joint frequency distribution of the variables, and the chi-square statistic (X^2) was used to test the significance of the relationship. For example, "gender" was tested against whether the visitor stopped (yes/no) to determine whether the two variables are related. To test for differences in the medians of two or more groups, the nonparametric Kruskal-Wallis (K-W) test was performed.[12] For example, "total time in the exhibition" was compared by "approximate age" to determine whether time spent in the exhibition is age-related.

Timing and tracking observation data is displayed in tables. Percentages within tables may not always equal 100 owing to rounding. Findings within each topic are presented in descending order, starting with the most-frequently occurring.

IN-DEPTH INTERVIEWS

In-depth interviews encourage individuals to express their opinions and feelings, describe their experiences and understandings, and share the meanings they construct from their museum visit. Additionally, the open-ended nature of interviews can provide evaluators with a deeper understanding of a visitor's perspective.

METHODOLOGY

RK&A conducted in-depth, open-ended interviews with CDM visitors in multigenerational groups (one adult and one child 4-10 years old) who had visited the *Mammoth Discovery!* exhibition (treatment group) and multigenerational groups who had not seen the exhibition (control group). Most control group interviews were conducted during Summer 2011, while treatment group interviews were conducted during Fall 2011 through Winter 2012.[13]

RK&A trained data collectors to recruit adults 18 years or older with one child age 4-10 years using a continuous random sampling method. In accordance with this method, the data collector imagined a predetermined line and selected the first eligible visitor to cross this imaginary line for observation. The imaginary line used to select control group visitors was located at a main Museum intersection midway between the entrance to the Museum and the entrance to *Mammoth Discovery!*; for treatment group visitors the imaginary line alternated between the entrance and exit to the exhibition.

After a visitor group was selected, they were asked two screener questions (i.e., whether they have visited *Mammoth Discovery!* and whether they are visiting with a child between the ages of 4 and 10 years).

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[11] Medians rather than means are reported in this document because, as is typical, the number of exhibits used and the time spent by visitors were distributed unevenly across the range. When the distribution of scores is extremely asymmetrical (i.e., "lopsided"), the mean is affected by the extreme scores and, consequently, falls further away from the distribution's central area. In such cases, the median is a better indicator of the distribution's central area because it is not sensitive to the values of scores above and below it—only to the number of such scores.

[12] The Kruskal-Wallis (K-W) test is a nonparametric statistical method for testing the equality of population medians of two or more groups. Nonparametric statistical methods do not assume that the underlying distribution of a variable is "normal," with a symmetric bell-shape, so they are appropriate for testing variables with asymmetric distributions such as "total time in the exhibition." The K-W test is analogous to a One-way Analysis of Variance, with the scores replaced by their ranks. The K-W test statistic H has approximately a chi-square distribution.

[13] A few control group interviews were conducted in winter 2012 to increase the number of interviews with Hispanic/Latino and Vietnamese interviewees.

If the visitor group met this criteria (was eligible) yet declined, the data collector logged the date, time, visitor's gender, estimated age, and reason for refusal. If a visitor group was eligible and agreed, they were invited to a separate quiet room[14] and were asked a series of open-ended questions using standardized interview guides (see Appendices G and H). The interview guides for the control and treatment groups were mostly the same except for some additional open-ended questions for the treatment groups that asked about their experience in the exhibition. Standardization was important as some of the interview data were scored with a rubric and analyzed quantitatively (described below). All interviews were audio-recorded with interviewees' permission and transcribed[15] to facilitate analysis. A small gift/toy was presented to each child to thank him/her for participating in the study.

Because CDM staff value their Vietnamese and Hispanic/Latino community members, either a bilingual Spanish-English interviewer or a bilingual Vietnamese-English interviewer was available for about one-half of all scheduled data collection. There are two exceptions to the random sampling method described above because certain visitors were recruited so that the interviewed sample represents CDM's audience.[16] First, in an effort to increase the number of Hispanic/Latino interviewees in the sample, bilingual interviewers were available on three separate occasions[17], and intercepted visitors at the Museum asking them to complete a demographic questionnaire. Visitors who self identified themselves as Hispanic/Latino were asked to participate in the interview. Second, in order to recruit additional Vietnamese interviewees, CDM asked a group of Vietnamese visitors who had scheduled a visit to the Museum to participate in the interviews. Eight family groups were selected, and interviews were conducted by a bilingual English-Vietnamese interviewer.

DATA ANALYSIS AND REPORTING

In-depth interviews produce qualitative data, meaning that results are descriptive following from the interviews' conversational nature. Interview data was analyzed in two ways: qualitatively and quantitatively.

Qualitative analysis

Portions of the treatment interviews, which all relate to visitors' experiences in *Mammoth Discovery!*, were analyzed qualitatively. In doing so, the evaluator studies verbatim transcripts for meaningful patterns, and, as patterns emerge, groups similar responses, eliciting trends in the data.

Data are presented in narrative in this report. Trends and themes within the data are presented in thematic sections. Within each section, findings are reported from most- to least-frequently occurring along with verbatim quotations (edited for clarity). In quotations, the interviewer's questions or comments appear in parentheses. If a quotation includes comments from more than one interviewee, the first speaker is identified by one asterisk (*), the second speaker by two asterisks (**), the third speaker by three asterisks (***), and so on. The genders and ages of interviewees are identified in brackets following the quotations.

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[14] Visitors were interviewed in pairs, one adult with one child aged 4 – 10 years. Other group members were asked to enjoy the Museum while the pair was interviewed. In the event that the adult was the only adult in the group, other children were invited to the room and were provided toys and books by the Museum.

[15] Interviews conducted in Spanish and Vietnamese were later transcribed and translated by the bilingual interviewer for further analysis.

[16] CDM believes that at least 20% of its visitors are Hispanic/Latino and 4-5% are Vietnamese.

[17] Two bilingual Spanish-English data collectors were available on a weekend day in December and one bilingual Spanish-English speaking data collector was available during two events targeting the Latino community: the Three Kings celebration weekend held January 7-8 2012 and the Luneda event held on February 4, 2012.

Quantitative analysis

Data from both control and treatment group interviews were analyzed quantitatively with a scoring rubric. A scoring rubric is a set of criteria linked to objectives for learning, perceptions and/or experiences; rubrics are used to assess performance of knowledge, skills, etc. on a continuum. In this study, the scoring rubric describes a continuum to measure indicators of the CDM's intended impact. Scoring rubrics are useful because they capture the nuances of visitors' experiences quantitatively, allowing outcomes to be measured. By doing so, RK&A can test independent variables, such as control versus treatment groups, against rubric scores to search for statistically significant relationships.

The scoring rubric includes a continuum of experiences and perceptions on a scale from 1, "Below Beginning," to 4, "Accomplished" (see Appendix I for the Scoring Rubric). RK&A used information gathered from the Community of Learners (a cohort of museum practitioners invited to participate in the professional development component of this project), CDM staff, the co-principal investigators on the project, and an early analysis of data from exit interviews to develop the rubric.

After developing the rubric, verbatim transcripts were scored on the 4-point scale described above by a trained data collector who had not conducted the interviews. Independently, the evaluator scored one-quarter of the interviews and compared her scores with the data collector to report the validity of the rubric. The validity of each scoring rubric is above 65 percent.

Data, including rubric scores and interviewees' demographic information, were analyzed using SPSS 12.0.1 for Windows. All statistical analyses run are listed in Appendix J. Descriptive statistical analyses included frequency distributions for all variables and summary statistics, such as the mean (average) and standard deviation (spread of scores: "±" in tables), for the rubric rating-scale variables and age.

To examine the relationship between two categorical variables, cross-tabulation tables were computed to show the joint frequency distribution of the variables, and the chi-square statistic (X^2) was used to test the significance of the relationship. For example, "percent of visitors who scored at the Below Beginning/Beginning level" was tested against "visited *Mammoth Discovery!*" to determine whether the two variables are related. All statistical tests employed a two-tailed 0.01 level of significance to preclude findings of little practical significance. Only statistically significant findings are presented in the report.

Data from the quantitative analysis of interviews using a rubric score is displayed in tables and figures. Percentages within tables may not always equal 100 owing to rounding. Findings within each topic are presented in descending order, starting with the most-frequently occurring.

REPORTING METHOD

In the body of the report, data are reported by methodology and without interpretation (see the discussion for interpretation of the findings). While there are two primary methodologies, the report is divided into three sections to account for the two distinct analyses of the interview data.

SECTIONS OF THE REPORT:

1. Timing and Tracking Observations
2. In-depth Interviews: Qualitative Analysis
3. In-depth Interviews: Quantitative Analysis

TIMING AND TRACKING OBSERVATIONS

INTRODUCTION

This section of the report presents findings from timing and tracking observations of children ages 4 to 10 years in the *Mammoth Discovery!* exhibition at CDM. The goal of this section is to present an account of what children and their visit group did in the exhibition. RK&A recorded the total time children spent in the exhibition and at individual exhibits and documented select behaviors, including science process skills and the type of interaction with adults in their visit group, data collection conditions, and demographics.

DATA COLLECTION CONDITIONS

A total of 111 children, ages 4 to 10 years old, were observed in the exhibition in October and November 2011. About two-thirds of observations took place on weekend days (67 percent), and observed children experienced a range of levels of crowding, with most experiencing moderate levels of crowding (44 percent) (see Table 1).

TABLE 1

DATA COLLECTION CONDITIONS

DAY OF THE WEEK (*n* = 111)	%
Weekend day	67
Weekday	33
CROWDING (*n* = 111)	**%**
Few	34
Moderate	44
High	22

VISITOR DESCRIPTIONS

This section describes the observed child and his/her visitor group.

OBSERVED CHILD

Data collectors recorded the gender and approximate age of each observed child. As shown in Table 2 (next page), the total sample includes slightly more females than males (54 percent and 46 percent, respectively). The majority of observed children were in the younger age group, age 4 to 7 years (71 percent).

TABLE 2

DEMOGRAPHIC CHARACTERISTICS OF OBSERVED CHILD

CHILD'S GENDER (n = 108[1])	%
Female	54
Male	46
CHILD'S APPROXIMATE AGE IN YEARS (n = 110[2])	**%**
4 – 7	71
8 – 10	29

[1] Gender data is missing for three children.
[2] Age data is missing for one child.

ADULTS AND CHILDREN ACCOMPANYING OBSERVED CHILD

Slightly more than one-half of observed children were visiting with adults and other children (55 percent) (see Table 3). More than two-thirds of children were visiting with just one adult (67 percent).

TABLE 3

GROUP COMPOSITION

GROUP COMPOSITION (n = 111)	%
Observed child with adults and other children	55
Observed child with adults only	45
NUMBER OF ACCOMPANYING ADULTS (n = 111)	**%[1]**
1	67
2	29
3	3
4	2
NUMBER OF ACCOMPANYING CHILDREN (n = 111)	**%[1]**
0	45
1	44
2	7
3	4

[1] Percentages may not total 100 owing to rounding.

Slightly more than one-half of children were accompanied by female adults only (55 percent) (see Table 4, next page). The majority of these adults were between the ages of 25 and 44 years old (87 percent) (see Table 4, next page).

TABLE 4

ADULT DEMOGRAPHICS

GENDER OF ACCOMPANYING ADULT(S) (*n* = 103)[1]	%[2]
Female adult(s) only	55
Male and female adult(s)	25
Male adult(s) only	19
ACCOMPANYING ADULTS' APPROXIMATE AGE IN YEARS (*n* = 107)[3]	**%[4]**
18 – 24	1
25 – 34	40
35 – 44	47
45 – 54	12
55 – 64	8
65 or older	3

[1] Data on gender of adults missing for 8 families
[2] Percentages may not total 100 owing to rounding
[3] Data on age of accompanying adults are missing for 4 families
[4] The total percentage exceeds 100 because observed children were accompanied by adults and children in multiple age categories.

Among accompanying children, most were seven years or younger (95 percent), and almost two-thirds of these children were younger than four years old (64 percent) (see Table 5).

TABLE 5

ACCOMPANYING CHILDREN'S APPROXIMATE AGE IN YEARS

ACCOMPANYING CHILDREN'S APPROXIMATE AGE IN YEARS (*n* = 61)[1]	%[2]
Less than 4	64
4 – 7	31
8 – 10	13
11 – 14	8

[1] Sixty-one observed children were accompanied by at least one child
[2] The total percentage exceeds 100 because observed children were accompanied by adults and children in multiple age categories.

OVERALL VISITATION PATTERNS

This section describes the total time spent in the exhibition and the total number of exhibits that children stopped at in the exhibition. Additionally, RK&A tested these findings by the observed child's demographic and visitation characteristics to explore differences by these factors.

TOTAL TIME IN THE EXHIBITION

Observed children's total time in *Mammoth Discovery!* ranged from 40 seconds to 40 minutes 48 seconds with a median time of 7 minutes 53 seconds (see Table 6). No statistically significant differences were found when the total time in the exhibition was examined by demographic and visitation characteristics.

TABLE 6
TOTAL TIME IN THE EXHIBITION

TIME (MIN:SEC) (*n* = 111)	%
Less than 5:00	40
5:00 – 9:59	19
10:00 – 19:59	27
20:00 or more	14
SUMMARY STATISTICS	**MIN:SEC**
Range	:50 – 40:48
Median time	7:53
Mean time	10:06
Standard deviation (±)	8:34

TOTAL NUMBER OF EXHIBITS STOPPED AT IN THE EXHIBITION

In the exhibition, the Museum identified 26 distinct exhibits or exhibit components.[18] For this evaluation, a "stop" means that a child stopped at an exhibit for three seconds or longer, including both physically engaging with the exhibit and observing the exhibit.

As shown in Table 7 (next page), children stopped at between one and twenty exhibits, and the median number of exhibits stopped at was six. Nearly one-half of observed children stopped at between five and eight exhibits (43 percent). No statistically significant differences were found when the total number of stops in the exhibition was examined by demographic and visitation characteristics.

[18] In this report, we use the word "exhibit" to identify *observable* subsections in the exhibition identified by the Museum and RK&A during a site visit. In some cases, two exhibits were combined for the purposes of observation due to their proximity (see Appendix A for a list of exhibits).

TABLE 7

TOTAL NUMBER OF EXHIBITS STOPPED AT IN THE EXHIBITION

NUMBER OF EXHIBITS (*n* = 111)	%
1 – 4	27
5 – 8	43
9 – 12	19
13 –16	7
17 – 20	4

SUMMARY STATISTICS (*n* = 111)	NUMBER OF EXHIBITS STOPPED AT
Range	1 – 20
Median number	6

VISITATION TO INDIVIDUAL EXHIBITS

This section describes the percentage of children who stopped at individual exhibits as well as the time spent at individual exhibits. Additionally, RK&A tested these findings by demographic and visitation characteristics to explore any differences by these factors.

INDIVIDUAL EXHIBITS STOPPED AT

RK&A calculated the percentage of children who stopped at each of the 26 exhibits (see Table 8, next page). About one-half of observed children stopped at "8. Look for Tiny Clues (dig pit)" (52 percent) and "26. Imagine the Past/Shadow Puppets" (50 percent). The lowest percentage of observed children stopped at "3. Where Were These Fossils Discovered? (map)" (3 percent) and "17. Mammoth News (couch)" (1 percent).

TABLE 8

PERCENTAGE OF CHILDREN WHO STOPPED AT INDIVIDUAL EXHIBITS

EXHIBIT(*n* = 111)	EXHIBIT TYPE	% OF OBSERVED CHILDREN WHO STOPPED
8. Look for Tiny Clues (dig pit)	Interactive	52
26. Imagine the Past/Shadow Puppets	Interactive	50
10. Focus on Details (dig pit)	Interactive	44
4. Compare Teeth	Interactive	42
18. What Does a Bone's Size Tell Us?	Interactive	41
9. Spin Movie	Interactive	37
16. What is Hidden? (rollerskate)	Interactive	37
12. Observe Carefully (tube with water & sand)	Interactive	36
14. Take a Closer Look/What Type of Bone is This? (real skull)	Interactive	35
20. Make a Model (big mammoth)	Interpretive Support	35
15. Dissect Evidence (poop)	Interactive	34
6. Try Making a Whole Bone Out of the Pieces Here	Interactive	33
24. Compare (weight)	Interactive	32
7. Notice Patterns (microscope)	Interactive	31
21. Study Modern Examples (xrays)	Interactive	31
23. Mammoth Puzzle	Interactive	29
1. Who Found these Fossils? (entry movie)	Interpretive Support	25
25. Computer Kiosks	Interactive	21
5. Can You Find the Molars? /Ask Questions	Interactive	19
22. Solve Mysteries (unknown skeleton)	Interactive	15
11. Tell a Story (story cards)	Interactive	10
19. Sit & Compare Your Thigh Bone to a Mammoth's/Measure Bones	Interactive	7
2. Imagine When Mammoths Roamed this Valley	Interpretive Support	6
13. How Does Something Become a Fossil?	Interpretive Support	5
3. Where Were These Fossils Discovered? (map)	Interpretive Support	3
17. Mammoth News (couch)	Interpretive Support	1

SIGNIFICANT RELATIONSHIPS

For exhibits stopped at by more than 20 observed children[19], RK&A tested whether demographic and visitation characteristics factored into exhibit stops. Several significant findings emerged:

- Older children, ages 8 to 10 years, are more likely than younger children, ages 4 to 7 years, to stop at "1. Who Found these Fossils? (entry movie)" (see Table 9, next page).

[19] Most exhibits were stopped at by at least 20 observed children.

- Observed children accompanied by both adults and other children are more likely than those children accompanied only by adults to stop at "7. Notice Patterns (microscope)" (see Table 10).
- Observed children accompanied by at least one child ages 11 to 14 years are more likely than children not accompanied by a child in this age range to stop at "4. Compare Teeth" (see Table 11).

TABLE 9

PERCENTAGE OF CHILDREN WHO STOPPED AT INDIVIDUAL EXHIBITS BY OBSERVED CHILD'S AGE

		OBSERVED CHILD'S AGE		
		YOUNGER (4-7 YEARS)	OLDER (8-10 YEARS)	TOTAL
EXHIBIT (*n* = 28)	EXHIBIT TYPE	%	%	%
1. Who Found these Fossils? (entry movie)[1]	Interpretive Support	18	44	25

[1]$\chi^2 = 7.961$; $df = 1$; p = .005 (Chi-square)

TABLE 10

PERCENTAGE OF CHILDREN WHO STOPPED AT INDIVIDUAL EXHIBITS BY GROUP COMPOSITION

		GROUP COMPOSITION		
		WITH ADULTS ONLY	WITH ADULTS AND CHILDREN	TOTAL
EXHIBIT (*n* = 34)	EXHIBIT TYPE	%	%	%
7. Notice Patterns (microscope)[1]	Interactive	18	41	31

[1]$\chi^2 = 6.931$; $df = 1$; p = .009 (Chi-square)

TABLE 11

PERCENTAGE OF CHILDREN WHO STOPPED AT INDIVIDUAL EXHIBITS BY INCLUSION OF CHILD AGES 11 TO 14 YEARS IN GROUP

		WITH AT LEAST ONE CHILD AGE 11 TO 14 YEARS		
		YES	NO	TOTAL
EXHIBIT (*n* = 47)	EXHIBIT TYPE	%	%	%
4. Compare Teeth[1]	Interactive	100	40	42

[1]$\chi^2 = 7.130$; $df = 1$; p = .008 (Chi-square)

TIME SPENT AT INDIVIDUAL EXHIBITS

See Table 12 (next page) for the amount of time children spent at each exhibit. Observed children spent the most time at "23. Mammoth Puzzle" (median time = 4 minutes 40 seconds) and "26. Imagine the Past/Shadow Puppets" (median time = 2 minutes 44 seconds). Children spent the least amount of time at "22. Solve Mysteries (unknown skeleton" (median time = 9 seconds) and "1. Who Found these

Fossils? (entry movie)" (median time = 6 seconds). No statistically significant differences were found when time spent at individual exhibits was examined by demographic and visitation characteristics.

TABLE 12

TIME SPENT AT INDIVIDUAL EXHIBITS

EXHIBIT	EXHIBIT TYPE	NUMBER OF CHILDREN WHO STOPPED	MEDIAN TIME (MIN:SEC)
23. Mammoth Puzzle	Interactive	32	4:40
26. Imagine the Past/Shadow Puppets	Interactive	55	2:44
18. What Does a Bone's Size Tell Us? (femur on wall)	Interactive	46	1:28
9. Spin Movie	Interactive	41	1:11
24. Compare (weight)	Interactive	35	1:07
25. Computer Kiosks	Interactive	23	:57
7. Notice Patterns (microscope)	Interactive	34	:52
10. Focus on Details (dig pit)	Interactive	49	:42
21. Study Modern Examples (xrays)	Interactive	34	:39
8. Look for Tiny Clues (dig pit)	Interactive	58	:38
12. Observe Carefully (tube with water & sand)	Interactive	40	:32
11. Tell a Story (story cards)	Interactive	11	:30
3. Where Were These Fossils Discovered? (map)	Interpretive Support	3	:30
15. Dissect Evidence (poop)	Interactive	38	:28
16. What is Hidden? (rollerskate)	Interactive	41	:25
4. Compare Teeth	Interactive	47	:20
6. Try Making a Whole Bone Out of the Pieces Here	Interactive	37	:19
13. How Does Something Become a Fossil? (layers)	Interpretive Support	5	:18
20. Make a Model (big mammoth)	Interpretive Support	39	:18
19. Sit & Compare Your Thigh Bone to a Mammoth's/Measure Bones	Interactive	8	:17
5. Can You Find the Molars? /Ask Questions	Interactive	21	:14
2. Imagine When Mammoths Roamed this Valley	Interpretive Support	7	:11
17. Mammoth News (couch)	Interpretive Support	1	:10
14. Take a Closer Look/What Type of Bone is This? (real skull)	Interactive	39	:10
22. Solve Mysteries (unknown skeleton)	Interactive	17	:09
1. Who Found these Fossils? (entry movie)	Interpretive Support	28	:06

EXHIBIT BEHAVIORS

This section describes how accompanying adults interacted with the observed children and how observed children engaged in specific science process skills and other types of exhibit-specific behaviors. See Appendix F for the percentages of children engaging in all exhibit-relevant behaviors and adult-child interaction styles at each exhibit, respectively.

ADULT-CHILD INTERACTION

RK&A observed adult-child interaction at exhibits and documented three types of interaction: adult observes, adult coaches, and adult collaborates. Also, RK&A documented whether an adult was present (chance that three behaviors may happen) or not present (no chance of adult-child interaction).

Table 13 summarizes the incidence of the accompanying adults' interaction style with the observed children across all exhibits. Specifically, it presents the percentages of families that engage in each type of interaction style at least once during their visit. The highest level of involvement observed for an adult and child at each exhibit visited was noted with Adult collaborates, which is considered the highest level of involvement. Almost three-quarters of adults were observed collaborating with the observed children at least once during their visit (73 percent). About one-half of adults were recorded as observing their children's engagement at an exhibit (52 percent). Lastly, about one-third of adults were observed coaching the observed child at least once while engaged with an exhibit (34 percent).

TABLE 13
SUMMARY OF ADULT-CHILD INTERACTION IN THE EXHIBITION

BEHAVIOR EXHIBITED AT LEAST ONCE IN THE EXHIBITION[1] (*n* = 111)	% OF FAMILIES
Adult collaborates	73
Adult observes	52
Adult coaches	34

[1]The total percentage exceeds 100 because accompanying adults exhibited multiple styles of interaction with the observed children over the observation period.

SIGNIFICANT RELATIONSHIPS

RK&A tested whether demographic and visitation characteristics factored into adult-child interaction styles. One significant finding emerged:

- When the level of crowding is high, adults are more likely to observe their children and less likely to collaborate with the observed children than during low to moderate levels of crowding (see Table 14, next page).

TABLE 14

ADULT INTERACTIONS WITH THE OBSERVED CHILD BY LEVEL OF CROWDING

		LEVEL OF CROWDING			
		FEW	MODERATE	CROWDED	TOTAL
ADULT-CHILD INTERACTION STYLE	*n*	%	%	%	%
Adult observes[1]	111	40	49	79	52
Adult collaborates[2]	111	68	88	50	73

[1] $\chi^2 = 9.666$; $df = 1$; $p = .008$ (Chi-square)
[2] $\chi^2 = 12.250$; $df = 2$; $p = .002$ (Chi-square)

SCIENCE PROCESS SKILLS

RK&A observed science process skill behaviors at exhibits throughout the exhibition in addition to other types of exhibit-specific behaviors. Specific behaviors that were considered to be indicative of science process skills were collapsed into five science process skill categories for analysis. These five categories are observing, comparing, using different tools, taking measurements, and testing/ experimenting. See Appendix C for the list of exhibit behaviors that were collapsed into each of these five science process skill categories. Data for all behaviors, including the exhibit-specific behaviors that were not considered to be indicative of science process skills, can be found in Appendix F.

Table 15 summarizes the incidence of the observed children's engagement with the five science process skills throughout the exhibition. Specifically, similar to how the adult-child interaction data was presented above, this table presents the percentages of observed children who engaged in each type of science process skill at least once during their visit.

Almost all of the observed children engaged in an observing behavior at some point during their visit (88 percent). More than three-quarters of observed children engaged at least once in testing/experimenting at an exhibit (78 percent) and in using different tools (76 percent). Almost two-thirds of these children engaged in comparing at an exhibit (60 percent). Finally, only a few children were observed taking measurements at an exhibit during their visit (3 percent).

TABLE 15

SUMMARY OF SCIENCE PROCESS SKILL BEHAVIORS IN THE EXHIBITION

BEHAVIOR EXHIBITED AT LEAST ONCE IN THE EXHIBITION (*n*=111)	% OF OBSERVED CHILDREN
Observing	88
Testing/Experimenting	78
Using Different Tools	76
Comparing	60
Taking Measurements	3

SIGNIFICANT RELATIONSHIPS

RK&A tested whether demographic and visitation characteristics factored into the observed children's engagement in science process skills. A couple significant findings emerged:

- Observed children who were accompanied by other children in addition to adults were more likely to engage in comparing behaviors at least once during their visit than those who were accompanied only by adults (see Table 16).
- Observed children who were accompanied by children ages 11-14 years old were more likely to engage in comparing behaviors during their visit than children who were not accompanied by children in this age range (see Table 17).

TABLE 16

COMPARING BY GROUP COMPOSITION

	GROUP COMPOSITION		
	WITH ADULTS ONLY	WITH ADULTS AND CHILDREN	TOTAL
SCIENCE PROCESS SKILL (*n* = 111)	%	%	%
Comparing[1]	44	72	60

[1] $\chi^2 = 9.021$; $df = 1$; p = .003 (Chi-square)

TABLE 17

COMPARING BY INCLUSION OF ACCOMPANYING CHILD AGES 11 TO 14 YEARS OLD

	WITH AT LEAST ONE CHILD AGE 11 TO 14 YEARS		
	YES	NO	TOTAL
EXHIBIT (*n* = 111)	%	%	%
Comparing[1]	95	52	60

[1] $\chi^2 = 11.835$; $df = 1$; p = .001 (Chi-square)

SUMMARY OF KEY FINDINGS

- Children's total time in *Mammoth Discovery!* ranged from 40 seconds to 40 minutes, 48 seconds., and the median time in the exhibition was 7 minutes, 53 seconds.
- Children spent the most time at the interactives "23. Mammoth Puzzle" (median time = 4 minutes 40 seconds) and "26. Imagine the Past/Shadow Puppets" (median time = 2 minutes 44 seconds).
- Children spent the least time at the interactive "22. Solve Mysteries (unknown skeleton)" (median time = 9 seconds) and the interpretive support "1. Who Found these Fossils? (entry movie)" (median time = 6 seconds).
- Children stopped at between one and twenty of the identified exhibit stops, and the median number of exhibits stopped at was six.
- The most popular exhibits were the interactives "8. Look for Tiny Clues (dig pit)" (52 percent of the observed children stopped) and "26. Imagine the Past/Shadow Puppets" (50 percent).

- The least popular exhibits were the interpretive support exhibits "17. Mammoth News (couch)" (1 percent of the observed children stopped) and "3. Where Were These Fossils Discovered? (map)" (3 percent).
- Observed children engaged in many science process skills in the exhibition. Most children demonstrated the science process skill of observing (88 percent), and many were testing/experimenting (78 percent), using different tools (76 percent), and comparing (60 percent).
- Adult-child interaction in the exhibition was high. Seventy-three percent of adults collaborated with their child in the exhibition—the highest level of adult-child interaction. However, when the level of crowding was high, adults were less likely to collaborate and more likely to observe.

IN-DEPTH INTERVIEWS: QUALITATIVE ANALYSIS

INTRODUCTION

In-depth interviews conducted by RK&A with *Mammoth Discovery!* visitors were analyzed both qualitatively and quantitatively. This section of the report presents the qualitative analysis of interviews. The goal of this analysis is to present a naturalistic account of visitors' experience in the exhibition. Qualitative analysis lends itself to this goal because it allows patterns and trends within visitors' responses to emerge organically. By comparison, the quantitative analysis of interviews, described in the next section, measures impact and looks at the interview data specifically through the lens of what CDM hoped to achieve.

VISITOR DESCRIPTIONS

Data collectors intercepted 289 adult visitors with children between 4 and 10 years, and a total of 119 visitor groups agreed to participate, while 170 declined, for a participation rate of 41 percent. A total of 84 interviews were analyzed qualitatively.[20] Of interviewees:

- Three-quarters of interviewed adults are female, and one-quarter are male;
- Adults' median age is 39;
- Five interviews were conducted in Vietnamese and two in Spanish.[21]
- More than one-half of interviewed children are male, and fewer than one-half are female;
- Children's median age is 6;
- The median number of adults per visit group is two; likewise the median number of children per visit group is two;
- Three-quarters of interviewees are repeat visitors to CDM, while one-quarter were visiting CDM for the first time;
- Three-quarters were visiting *Mammoth Discovery!* for the first time, while one-quarter had visited the exhibition at least once before.

OPINIONS OF OVERALL EXPERIENCE

TOP-OF-MIND RESPONSE

When asked how they felt overall about *Mammoth Discovery!,* most interviewees responded positively about the exhibition and their experience. About one-quarter of interviewees liked that many of the exhibits were interactive and that they had opportunities to touch the bones and do hands-on activities. One-quarter of interviewees liked that the exhibition was informative or educational; some of these

[20] Some interviews were removed from the sample for various reasons, including interview audio quality and completion.
[21] Bilingual English-Spanish and bilingual Vietnamese-English data collectors were available. There were no noticeable differences in the responses of visitors who spoke Spanish, Vietnamese, or English.

interviewees appreciated the opportunity to learn about scientific processes specifically. For instance, one interviewee said:

> Adult: I really appreciated that they represented a lot of the scientific aspects of archeology. We liked digging for the bones and brushing off and seeing—having like archeological tools there. . . . She really liked the stories of what really—like you get to the timeline, and they give the different pieces. It was cool because she would sit down and she would speculate about what it was and what order she thought things happened, which is exactly what an archeologist would do. [female 41 and female 5]

Additionally, several interviewees liked that the exhibition showed what scientists do. For example, one interviewee said:

> Adult: I liked how the exhibit asked questions and then it says, 'You're pretending to be a scientist.' And it says like, 'Look at these teeth. By looking at these teeth can you guess what the animal ate?,' instead of just telling some things. Although, I was looking for answers too, and I wasn't sure what the answer were. But I thought it was good to have those questions. They'll get you curious, and then you have to sort of look at it a little bit deeper to try to make some meaning of it. [female 50 and male 11]

Some described the whole exhibition as "fun." On the other hand, a few others said the exhibition seemed to target older children and thus was not fitting for their children.

LIKED MOST

When asked what they liked most about *Mammoth Discovery!*, nearly all interviewees described one or more specific exhibits. The most frequently named exhibits, mentioned by between one-quarter and one-third of interviewees, were "Make a Model," the dig pits[22], "Mammoth Puzzle," and "What Does a Bone's Size Tell Us?"; other frequently mentioned exhibits were "Imagine the Past," "Observe Carefully," "Notice Patterns," "Compare," "Compare Teeth," and the "Computer Kiosks."

Interviewees liked certain exhibits for a variety of reasons. Specifically, some interviewees liked "Make a Model" largely because it gave them a sense of the mammoth's large size. For example, one adult and child pair said:

> Adult: I like the big skeleton; that was kinda cool. Child: Which one? Adult: Remember I said, 'Wow! Look at how big this thing is!' Child: Oh yeah, the big mammoth we saw . . .
> Adult: Can you imagine yourself standing next to it? [female 43 and female 9]

A few other interviewees liked "Make a Model" because it provided a good point of comparison with other exhibits in the exhibition. One man said:

> Adult: . . . It's nice to see the one [big mammoth skeleton] out first and then see how it's broken up rather than seeing the broken up pieces first and the mammoth. [male 46 and female 7]

Some interviewees said they liked the dig pits because they were a great hands-on exhibit for children—allowing children to participate and touch. Some others liked the dig pits because they provided a

[22] Interviewees did not specify which of the two dig pits they were referring to.

paleontological experience that adults found engaging and authentic. For example, when the interviewer asked, "What did you like most about the exhibition?,"one woman said:

> Adult: The fossil site, I've always wanted to get into archeology, but it didn't happen. . . . It gave a good [overview], from the beginning to end, everything that's involved [in a dig]. [female 33 and female 7]

Some interviewees said they liked that there were real fossils or bones displayed within the exhibition. However, a few of these interviewees mistook replicas for authentic fossils.

LIKED LEAST

When asked what they least enjoyed about the exhibition, most interviewees did not name anything. Several others said some exhibits needed more explanation. In particular, a few interviewees said "What Does a Bone's Size Tell Us?" was confusing, and a couple did not find "Dissect Evidence" engaging.

UNDERSTANDING OF EXHIBITION MESSAGES

Data collectors asked interviewees several questions to determine what ideas they took away from *Mammoth Discovery!*. Data are organized by the messages CDM hopes for visitors to take away from the exhibition; within these messages, RK&A distinguishes between whether these messages were top-of-mind or unprompted (came out naturally in response to open-ended questions about the exhibition) or were elicited with prompting (visitors were asked pointed questions about the messages).

MAMMOTHS AND MAMMOTH BIOLOGY

About two-thirds of interviewees said that they learned something about mammoths and mammoth biology in the exhibition. For instance, more than one-half of interviewees said they learned size and weight of mammoths, with some saying they learned about the size and weight of mammoths in comparison to other animals, people and/or objects at the "Compare" exhibit. Additionally, some others learned about characteristics of mammoths; a few talked about mammoths' teeth and what kinds of food they ate, while a few others talked about how mammoths have tusks and are related to elephants. For example, when the interviewer asked, "What would you say the exhibition is about?," one woman said:

> Adult: Yeah, the study of mammoths and when they lived, and when, where were they discovered, and what else, and how big they are and what they look like. What the bones look like. [female 39 and male 7]

Additionally, a few said they learned that mammoths lived long ago and are now extinct.

LUPE

Unprompted, about one-fifth of interviewees talked about the narrative of the specific mammoth, Lupe, being discovered and the process of finding out more about Lupe.[23] About one-half of these interviewees connected the discovery to the local area of San Jose. For example, when the interviewer asked one adult and child pair, "What would you say the exhibition is about?", they said:

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[23] As noted below, more interviewees talked about Lupe when asked specifically about what they found out about the San Jose area in the exhibition.

> Child: The woolly mammoth. (Can you tell me more about that?) Child: Ummm. Adult: The woolly mammoth, do we have them now? Do we have them in our neighborhood? Child: No. Adult: When were they from? Child: They lived when the dinosaurs were here and before them I think. Adult: So they've been there a long time. They're ancient animals. And, where was this woolly mammoth discovered? Why is it in this Museum? What's so interesting about it? Child: I don't know. Adult: It was discovered I think in the Guadalupe River which is really close to here, in walking distance. It's amazing they found dinosaur remains right next to the Museum. It's really incredible that it's local. [male 47 and female 6]

Additionally, one interviewee recalled that the person who discovered the bones was not a scientist. For example, when describing what they thought the exhibition was about, one child and adult pair said:

> Child: A mammoth that was found here in San Jose, in San Jose airport. . . .(And tell me more about that?) Child: I don't know anything else about that. Adult: Do you know who found it? Child: Yeah. A guy who was walking, a scientist. Adult: No it wasn't the scientist. Child: Guy who had a dog, and the dog was sniffing a place and wouldn't go. And they just dug it up. [female 37 and female 9]

SAN JOSE AREA

Interviewees were asked what, if anything, they found out about the San Jose area while in the exhibition. Almost two-thirds said that mammoths used to live in the San Jose area or that mammoth bones were discovered there. About one-quarter of interviewees gave specific examples about the finding of Lupe. For instance, some said that a mammoth was discovered by a river, with some specifically referring to the Guadalupe River, like in the excerpt below:

> (What if anything did you find out about the San Jose area?) Child: I don't know. Adult: Where was the thing, where was she, where did they find her? Child: On the Lupe river? Adult: Do you know where that is? Child: No. Adult: Oh, that's very, very close to here, and so long ago mammoths used to walk right where we, where we're sitting. And there was no building here. [female 41 and female 5]

A few of the interviewees said they were surprised to learn that a mammoth was found in the area. For example, one adult said:

> (What if anything did you find out about the San Jose area?) Adult: We're not from here, and it showed where the mammoth was found. I didn't know it was a mammoth from the area. On the wall, it's like oh we found this by the airport so it's like oh okay, I didn't realize that, I just thought you had a mammoth exhibit because you are a children's museum. So that was really cool that it is something from your area so that was really nice because it's something local because you know kids read about dinosaurs and things in books but to find something locally is really cool. It's like hey this is a mammoth from up the road. [female 46 and male 10]

Slightly more than one-third of interviewees said that they did not learn anything about the San Jose area in the exhibition or they responded by talking about their general knowledge about San Jose and their experience visiting or living in the area.

SCIENTIFIC THINKING AND PROCESS

UNPROMPTED RESPONSE

Scientific thinking and the scientific process was top-of-mind for several visitors. For instance, when asked what they thought the exhibition was about, several interviewees said that the exhibition was not

just about mammoths, but about scientific processes. Interviewees named such processes as discovery and observation, how we know what we know, and learning how scientists figure things out (see the quotations below for examples).

> (What would you say the exhibition is about?) Child: About fossils and mammoth fossils and what scientists do to recreate them and how fossils are preserved. I also like that thing you can turn and you can see uncovering the fossil, finding a fossil, recovering a fossil. Adult: The different stages. Child: Yeah, and that kind of showed me what they did to get the fossil out of the ground. They picked it. They dug it. They were very gentle. Adult: . . . . And then a lot of it was about, like he said, how do you go about discovering it, the bones, and then how do you figure out, once you get them, that it's a mammoth or that it's old or that it's a male or female—all that kind of stuff. [female 50 and male 11]

> (What would you say the exhibition is about?) Child: I would say the exhibit is about learning stuff. (And tell me more about that?) Child: And I think which is also because they want you to learn how to do what scientists do. [female 42 and male 7]

Additionally, a few of these interviewees explicitly said that they used scientific tools in the exhibition. For example, one adult said:

> Adult: . . . it's about wooly mammoths, but it's also about using the tools of a scientist and having the mind and the inquiry and you know using all the different senses to kind of explore and discover. [female 33 and male 6]

PROMPTED RESPONSE

When asked specifically about what they learned about science through the exhibition, about two-thirds of interviewees gave a specific example. A few named specific scientific facts, but the majority talked about scientific thinking and the scientific process. For instance, about one-half of visitors said they learned about what scientists do. Some interviewees said the dig pits made them feel like a scientist or a paleontologist because they had to dig for bones, clean them, and figure out what kinds of bones they are (see the quotations below for examples).

> (Could you tell me what you did in there, in the exhibition, the one you just saw?) Child: We went in the sand area. (What did you learn, if anything, from that activity?) Child: More about what scientists do and brushing off and making seeing better. Adult: Yeah it gave them a real experience of seeing how scientists go about studying artifacts. [male 47 and female 6]

> (What did you learn from that activity?) Adult: What did you learn from that activity?
> Child: That it takes a lot of work to find out what, what it really is and I can imagine how hard it is for a scientist to find all those bones and figure out what that is and arrange the bones together. [female 37, female 9, and male 5]

OTHER MESSAGES

Some interviewees had more simplistic ideas about what the exhibition was about. The majority of these interviewees said that the exhibition was simply about bones and fossils (often specifying animal bones and fossils) (see the quotations below for examples). A few said it was about animals.

> (What would you say the exhibition is about?) Child: Ahhh the bones. I think like fossils and bones and some stuff, yeah. [female 49 and female 7]

Adult: Is it about dinosaurs, bones, finding bones, what is it about? Child: Finding bones. Adult: Finding bones. [female 37 and male 6]

SUMMARY OF KEY FINDINGS

- Most interviewees responded positively about the exhibition and their experience.
- About two-thirds of interviewees learned something about mammoths and mammoth biology in the exhibition.
- Two-thirds understood that mammoths used to live in the San Jose area or that mammoth bones were discovered there.
- Two-thirds of interviewees took away ideas about scientific thinking and the scientific process.

IN-DEPTH INTERVIEWS: QUANTITATIVE ANALYSIS

INTRODUCTION

This section of the report presents the quantitative analysis of interviews conducted with CDM visitors. Purposefully, about one-half of the interviewees had experienced the exhibition (treatment group), while about one-half had not (control group) with the goal of measuring the impact of *Mammoth Discovery!*. Data were analyzed using rubrics developed around the four impact statements articulated by CDM; each rubric contains a continuum of knowledge, awareness, or skill, where 1 is "Below Beginning" and 4 is "Accomplished." The rubrics were developed and refined over time through a rubrics workshop facilitated by RK&A for CDM staff as well as actual interview data.

VISITOR DESCRIPTIONS

Data collectors intercepted 515 visitors, and a total of 232 visitor groups agreed to participate, while 283 declined, for a participation rate of 45 percent.[24] There are no statistical differences between visitors who participated in the interviews versus those who declined.

DEMOGRAPHICS

Almost three-quarters of interviewed adults are female (71 percent), and more than one-quarter are male (29 percent) (see Table 18). The median age of interviewed adults is 39. There are no differences in gender and age between the control and treatment group.

TABLE 18

ADULT'S DEMOGRAPHICS BY GROUP

	GROUP		
	CONTROL	TREATMENT	TOTAL
ADULT'S GENDER (*n* = 178)	%	%	%
Female	69	74	71
Male	31	26	29
ADULT'S AGE [1] (*n* = 176)	%	%	%
17 – 24	3	2	3
25 – 34	20	23	21
35 – 44	53	52	53
45 – 54	13	16	14
55 – 64	4	5	5
65+	7	2	5

[1]Total age: range = 17-78; median = 39; mean = 40.4 (± 10.29)

[24] Some interviews were removed from the sample for various reasons, including interview audio quality and completion.

About one-half of interviewed children are female (51 percent), and one-half are male (49 percent) (see Table 19). The median age of interviewed children is 6. There are no differences in gender and age between the control and treatment group.

TABLE 19

CHILD'S DEMOGRAPHICS BY GROUP

	GROUP		
	CONTROL	TREATMENT	TOTAL
CHILD'S GENDER (*n* = 178)	%	%	%
Female	57	44	51
Male	43	56	49
CHILD'S AGE [1] (*n* = 178)	%	%	%
3 – 7	63	70	66
8 – 11	37	30	34

[1]Total age: range = 3 – 11 ; median = 6; mean = 6.6 (± 1.90)

GROUP COMPOSITION

More than one-half of interviewees said they were visiting in a group containing two adults (53 percent) (see Table 20). Likewise, almost one-half of interviewees said they were visiting in a group containing two children (46 percent). There are no differences in the number of children and adults in visit groups between the control and treatment group.

TABLE 20

NUMBER OF ADULTS AND CHILDREN IN VISIT GROUPS BY GROUP

	GROUP		
	CONTROL	TREATMENT	TOTAL
NUMBER OF ADULTS[1] (*n* = 178)	%	%	%
1 adult	32	41	36
2 adults	56	50	53
3 adults or more	12	10	11
NUMBER OF CHILDREN[2] (*n* = 178)	%	%	%
1 child	36	25	35
2 children	43	49	46
3 children	15	7	11
4 children or more	6	10	8

[1]Total number of adults in visit group: range = 1 – 10 ; median = 2; mean = 1.9 (± 1.02)
[2]Total number of children in visit group: range = 1 – 15 ; median = 2; mean = 2.1 (± 1.44)

VISITATION

About two-thirds of interviewees are repeat visitors to CDM (65 percent), and about one-third have visited CDM four times or more (36 percent) (see Table 21). There is a statistical difference in visitation by control and treatment group:

- Treatment group interviewees are more likely than control group interviewees to be repeat visitors to the CDM (75 percent versus 56 percent).

TABLE 21

CDM VISITATION BY GROUP

	GROUP		
FIRST-TIME OR REPEAT VISITOR TO CDM[1] (*n* = 177)	**CONTROL**	**TREATMENT**	**TOTAL**
	%	**%**	**%**
Repeat	56	75	65
First-time	44	25	35
NUMBER OF CDM VISITS[2, 3] (*n* = 176)	**%**	**%**	**%**
Once (first-time)	44	25	35
Twice	19	19	19
3 times	12	8	10
4 or more times	25	48	36

[1] $\chi^2 = 7.064$; *df* = 1; p = .008 (Chi-square)
[2] $\chi^2 = 11.618$; *df* = 3; p = .009 (Chi-square)
[3] Total number of CDM visits: range = 1 – 100 ; median = 2; mean = 4.8 (± 9.16)

Of treatment group interviewees, three-quarters were visiting *Mammoth Discovery!* for the first time that day, while one-quarter had visited the exhibition at least one time before (25 percent) (see Table 22).

TABLE 22

***MAMMOTH DISCOVERY* VISITATION**

	TREATMENT
FIRST-TIME OR REPEAT VISITOR TO *MAMMOTH DISCOVERY* (*n* = 81)	**%**
First-time	75
Repeat	25

INTERVIEWEE LANGUAGE

Most interviews were conducted in English (91 percent), a few in Vietnamese (6 percent), and a few in Spanish (3 percent) (see Table 23).

TABLE 23

INTERVIEWEE LANGUAGE

	GROUP		
	CONTROL	TREATMENT	TOTAL
LANGUAGE (*n* = 178)	%	%	%
English	90	92	91
Vietnamese	5	6	6
Spanish	4	2	3

ACHIEVEMENT OF IMPACT

CDM articulated four impacts at the beginning of the project:

1. Children and their caregivers will engage in scientific thinking (i.e., science as a creative process).
2. Children and their caregivers will become aware that they can and are engaging in a process similar to that in which scientists engage.
3. Children and their caregivers will learn about mammoths and their habitats and will understand that knowledge about mammoths is based on evidence.
4. Caregivers will support children's learning through collaborative exploration.

These four impacts were measured using one or more rubrics developed around the impacts. All rubrics measured interviewees' achievement on a continuum from 1,"Below Beginning," to 4, "Accomplished." In reading this section, please note that there are two distinct types of rubrics used:

1. Rubrics that measure control and treatment interviewees' achievement based on an activity that required interviewees to identify an unknown object (shows transfer).
2. Rubrics that measure treatment interviewees' achievement based on their accounts of their experiences in the exhibition.

Three rubrics were used to measure the impact 1, three rubrics to measure the impact 2, one rubric to measure the impact 3, and two rubrics to measure the impact 4. In the next few pages, the findings are reported by rubric with an explanation of the criteria used to measure impact and with exemplary quotations of high scoring and low scoring responses. On most rubrics, questions were directed to interview children and their caregiver; we use the shorthand C/C to identify the child and caregiver unit.

IMPACT 1

RUBRIC 1A (ACTIVITY)

Rubric 1a describes the continuum on which children or caregivers (C/C) identify visual or tactile clues or evidence (e.g., describe color, size, shape, feel of the object) while working to identify an unknown object. See Table 24 for the rubric criteria and examples of the lowest and highest achievement.

TABLE 24

CRITERIA AND EXAMPLES FOR RUBRIC 1A (ACTIVITY)

	1 - Below Beginning	2 – Beginning	3 – Developing	4 – Accomplished
Criteria	C/C do not identify any visual or tactile clues or pieces of evidence. May jump to interpretation (e.g., "It is a fossil).	C/C identify one to two visual or tactile clue or piece of evidence. (Reader would have a vague idea of what the object looks like.)	C/C identify two to three visual or tactile clues or pieces of evidence. (Reader would have a good idea of what the object looks like.)	C/C identify four or more visual or tactile clues or pieces of evidence. (Reader would have a clear idea of what the object looks like.)
Example	Caregiver: What does it look like? Child: A foot. Caregiver: A foot? From what? Child: A mammoth? Caregiver: A mammoth's foot? (How did you decide what this is?) Child: Cause it looks like a foot right here. Caregiver: It looks like the bottom of a shoe. (What makes you say that?) Caregiver: You just knew it looks like that, right? [female 41 and female 6]		Caregiver: It's got an interesting shape doesn't it, interesting texture. . . . And what color is it? Child: Brown. Caregiver: All one color or darker on the top? It's kind of black on the top. Child: Maybe it's the mouth. Caregiver: Looks like teeth doesn't it, part of the bottom broke off? (How did you decide what this is?) Caregiver: Does it look like a shoe? Child: No. Caregiver: It's the shape of a shoe, but we know it's not a shoe, right? It's not soft, not rubber. What is it made out of? It's really hard; you can break something with that. Maybe it's bone, animal bone? Child: Yeah. (What makes you say that?) Caregiver: Can you tap your fingers on it? So it's very what? Child: Hard. Caregiver: A hard surface, yeah. [male 47 and female 6]	

Table 25 shows achievement on Rubric 1a. About two-thirds of interviewees scored at the low end of the continuum (68 percent scored at "1 – Below Beginning" or "2 – Accomplished"), and one-third scored at the high end (33 percent scored at "3 – Developing" or "4 – Accomplished"). While more control than treatment interviewees scored at the high end of the continuum (40 percent versus 23 percent), the difference is not statistically significant.

TABLE 25

SCORES ON RUBRIC 1A BY GROUP

	GROUP		
	CONTROL	TREATMENT	TOTAL
RUBRIC LEVELS (*n* = 178)	%	%	%
4 – Accomplished	17	4	11
3 – Developing	23	19	21
2 – Beginning	48	56	52
1 – Below Beginning	12	21	16

RUBRIC 1B (ACTIVITY)

Rubric 1b describes the continuum on which C/C offer explanations based on visual or tactile evidence (see Table 26).

TABLE 26

CRITERIA AND EXAMPLES FOR RUBRIC 1B (ACTIVITY)

	1 - Below Beginning	2 – Beginning	3 – Developing	4 – Accomplished
Criteria	C/C offer hypotheses, but they do not explain how visual or tactile evidence informed the hypotheses.	C/C offer hypotheses that are loosely based on visual or tactile evidence. Their description may be circular or illogical (repeats the hypothesis citing it as evidence) (e.g., it's a tooth because it looks like a tooth).	C/C offer hypotheses that are somewhat based on visual and tactile evidence. Their hypotheses may be informed by previous knowledge and/or experiences as evidence (e.g., "we've seen a lot of dinosaur bones and this looks similar to dinosaur bones").	C/C offer hypotheses about the object that is largely based on visual and tactile evidence. The hypotheses may also refer to previous knowledge and/or experience, but C/C make explicit connections between the hypotheses and evidence.
Example	(So how did you decide what this is?) Caregiver: How did we decide? Just the way it looks I guess. It looks like a bone I guess. (How do you know it's a bone?) Caregiver: We don't. I was taking a random guess. [male 31 and female 4]		Child: Molar. I think it might be a molar because it has these ridges right here. (And how do you know it's a molar?) Child: Because like our mouths, it isn't smooth and it isn't pointed straight up and it has these little bumps. It has bumps. And it doesn't have one bump it has like a bump up and then a bump down and then there's two bumps and there's a space in between them. [male 44 and male 7]	

Table 27 shows achievement on Rubric 1b. More than two-thirds of interviewees scored at the low end of the continuum (71 percent scored at "1 – Below Beginning" or "2 – Beginning"), and almost one-third scored at the high end (30 percent scored at "3 – Developing" or "4 – Accomplished"). While more control than treatment interviewees scored at the high end of the continuum (32 percent versus 27 percent), the difference is not statistically significant.

TABLE 27

SCORES ON RUBRIC 1B BY GROUP

	GROUP		
	CONTROL	TREATMENT	TOTAL
RUBRIC LEVELS (*n* = 177)	%	%	%
4 – Accomplished	6	8	7
3 – Developing	26	19	23
2 – Beginning	45	53	49
1 – Below Beginning	23	19	22

RUBRIC 1C (EXHIBITION)

Rubric 1c describes the continuum on which C/C describe the science activities/ process skills they used in the exhibition, such as observation, questioning, comparing, piecing together clues, using different tools, prediction, measurement, inference, and classification (see Table 28). It applies to treatment visit interviewees only.

TABLE 28
CRITERIA AND EXAMPLES FOR RUBRIC 1C (EXHIBITION)

	1 - Below Beginning	2 – Beginning	3 – Developing	4 – Accomplished
Criteria	C/C do not describe science activities/ process skills they used in the exhibition (e.g., "used the water activity and puppet show"). C/C may list the things they saw in the exhibition or only describe something they read on a text panel.	C/C describe science activities/process skills they used in the exhibition, but do not explain the purpose of the activity or process in which they engaged/ do not understand that they engaged in a science activity/ process skill (e.g., "we looked at the bones and used a microscope").	C/C describe science activities/process skills they used in the exhibition and provide a vague or cursory explanation of the purpose of the activity or process in which they engaged /some understanding that they engaged in a science activity/ process skill (e.g., we looked at bones and saw how animal bones differ.")	C/C describe science activities/process skills they used in the exhibition and provide a clear explanation of the purpose of the activity or process in which they engaged / understand that they engaged in a science activity/ process skill (e.g., we uncovered bones like a paleontologist and scrubbed them but not too aggressively).
Example	(Could you tell me what you did in the exhibit?) Child: Did that puzzles. (So the puzzles? And tell me more about the puzzle.) Child: It was a hard puzzle, but we still did it. (What did you learn from that activity?) Child: The dinosaur is that big. [male 36 and male 5]		Child: It was cool to be able to be like an archeologist, like digging for the bones and looking through the micro-scope. Caregiver: Did you like to cleaning them off? Did you like the digging part? Child: Yeah. . . . I liked the digging and trying to figure out what parts match. (Could you tell me what you did in the exhibition?) Child: You got to look at bones, look at the different skulls and teeth that they had, and you got to figure out how and what they ate. [female 37 and female 4]	

Table 29 shows achievement on Rubric 1c. Almost two-thirds of interviewees scored at the high end of the continuum (61 percent scored at "3 – Developing" or "4 – Accomplished"), and almost one-third scored at the low end (40 percent scored at "1 – Below Beginning" or "2 – Beginning").

TABLE 29
SCORES ON RUBRIC 1C BY GROUP

	TREATMENT
RUBRIC LEVELS (*n* = 83)	%
4 – Accomplished	15
3 – Developing	46
2 – Beginning	28
1 – Below Beginning	12

IMPACT 2

RUBRIC 2A (ACTIVITY)

Rubric 2a describes the continuum on which C/C understand the science activities/process skills that scientists engage in to interpret an unknown object such as, observation, questioning, comparing, using different tools, prediction, measurement, inference, and classification (see Table 30).

TABLE 30

CRITERIA AND EXAMPLES FOR RUBRIC 2A (ACTIVITY)

	1 - Below Beginning	2 – Beginning	3 – Developing	4 – Accomplished
Criteria	C/C do not provide any examples activities/ process skills that scientists may engage in to interpret an unknown object. C/C may provide superficial examples of what a scientist does (e.g., "Scientists study things," "talk with their colleagues," or "look things up online or in a book.").	C/C describe science activities/process skills that scientists may engage in to interpret an unknown object, but do not explain the purpose of the activity (e.g., "Scientists look for other clues," or "use different tools and run experiments.").	C/C describe specific science activities/process skills that scientists may engage in to interpret an unknown object and provide a vague or cursory explanation of the purpose of the activity or process skill (e.g., "compare the bones to other animals").	C/C describe specific science activities/ process skills that scientists may engage in to interpret an unknown object and provide a clear explanation of the purpose of the activity or process skill (e.g., "use carbon dating to find out how old it is" or "look for other bones in a dig area to try and recreate the animal").
Example	Caregiver: Just, I think scientists have lots of knowledge and they have experience so they would think about where you found it [an object]. [female 40 and male 5]		Child: Probably, [the scientist would] look at what he already knew, do a little computer research, scan the bone a few times, put it to a few… Caregiver: To try and match with what data that exists in a database. Child: Yeah. Research it for a while, get a few experts in there and different things, and make a hypothesis, do an experiment, come up with what he thinks is an answer, gets, do some more research off that, and come up with an answer he's pretty sure is right. [female 49 and male 8]	

Table 31 shows achievement on Rubric 2a. About two-thirds of interviewees scored at the high end of the continuum (67 percent scored at "3 – Developing" or "4 – Accomplished"), and one-third scored at the low end (34 percent scored at "1 – Below Beginning" or "2 – Beginning"). While more control than treatment interviewees scored at the high end of the continuum (68 percent versus 65 percent), the difference is not statistically significant.

TABLE 31

SCORES ON RUBRIC 2A BY GROUP

	GROUP		
	CONTROL	TREATMENT	TOTAL
RUBRIC LEVELS (*n* = 177)	%	%	%
4 – Accomplished	29	23	26
3 – Developing	39	42	41
2 – Beginning	29	29	29
1 – Below Beginning	3	6	5

RUBRIC 2B (ACTIVITY)

Rubric 2b describes the continuum on which C/C describe themselves as having engaged in scientific activities similar to scientists while working to describe an unknown object (see Table 32).

TABLE 32

CRITERIA AND EXAMPLES FOR RUBRIC 2B (ACTIVITY)

	1 - Below Beginning	2 – Beginning	3 – Developing	4 – Accomplished
Criteria	C/C do not identify any similarities between what they did or what they may do to identify an unknown object and what scientists do. (See what they did or may do as completely different from what scientists do).	C/C describe vague similarities between what they did or what they may do to identify an unknown object and what scientists do. (See what they did or may do as mostly different from what scientists do).	C/C describe some similarities between what they did or what they may do to identify an unknown object and what scientists do. (See what they did or may do as somewhat different from what scientists do).	C/C describe strong similarities between what they did or what they may do to identify an unknown object and what scientists do. (See what they did or may do as similar or minimally different from what scientists do).
Example	(How is what a scientist does similar to what you did?) Caregiver: [They] have to describe what it looks like and what it feels like and maybe they can infer in it what it is. (How is what a scientist does different from what you did?) Caregiver: Scientists can do a lot of tests, right? They have instruments that they can use to test how old it is. Don't be shy. Child: I don't know. Caregiver: You think they know about it more? They're smarter, so they know what it is. [female 26 and male 6]		(How is what a scientist does similar to what you did?) Caregiver: Investigating something new by looking and feeling. Child: Yeah. Caregiver: And looking at books about it, although we didn't get to do that today, but that's what we think they might do, right? Checking how it fits with other parts that they might have. (How is what a scientist does different than what you did?) Child: They get some fossils. Caregiver: And we didn't have to dig this up; it was sitting here for us, right? [female 35 and male 4]	

Table 33 shows achievement on Rubric 2b. More than one-half of interviewees scored at the low end of the continuum (55 percent scored at "1 – Below Beginning" or "2 – Beginning"), and almost one-half scored at the high end (46 percent scored at "3 – Developing" or "4 – Accomplished"). While more control than treatment interviewees scored at the high end of the continuum (49 percent versus 40 percent), the difference is not statistically significant.

TABLE 33

SCORES ON RUBRIC 2B BY GROUP

	GROUP		
	CONTROL	TREATMENT	TOTAL
RUBRIC LEVELS (*n* = 175)	%	%	%
4 – Accomplished	32	7	21
3 – Developing	17	33	25
2 – Beginning	39	50	44
1 – Below Beginning	12	10	11

RUBRIC 2C (EXHIBITION)

Rubric 2c describes the continuum on which C/C describe themselves as having engaged in scientific activities similar to scientists in the exhibition (see Table 34). It applies to treatment interviewees only.

TABLE 34

CRITERIA AND EXAMPLES FOR RUBRIC 2C (EXHIBITION)

	1 - Below Beginning	2 – Beginning	3 – Developing	4 – Accomplished
Criteria	C/C do not identify any similarities between what they did in the exhibition and what scientists do. (See what they did and what scientists do as completely different).	C/C describe vague similarities between what they did in the exhibition and what scientists do. (See what they did and what scientists do as mostly different).	C/C describe some similarities between what they did in the exhibition and what scientists do. (See what they did and what scientists do as somewhat different).	C/C describe strong similarities between what they did in the exhibition and what scientists do. (See what they did and what scientists do as similar or minimally different).
Example	(And how is what a scientist does similar to what you did in the exhibition?) Caregiver: Did we try some different things out? Scientists do that. (And how is what a scientist does different from what you did in the exhibition?) Child: They don't play. Caregiver: They don't play, yeah. [female 40 and male 4]		(How is what a scientists does different from you did in the exhibition?) Caregiver: That'd be pretty similar, but they would probably do a lot more things with it. Child: They would probably look somewhere like here see if there's anything there or like look at the cracks here. Caregiver: Right. So we were looking at it in a big way and we can look at it a magnifying glass, look at different parts. And then like you said, you could put it up to different bones and stuff like you did over there. But a scientist maybe they would, they would do something very similar. They might be a little bit more systematic about it; that's big word for going part by part, and then saying 'Mmmm, it doesn't fit the mammoth so that means it's not a mammoth then. Maybe it fits the bison, but not exactly.' So they might put it into different categories. [female 37 and male 6]	

Table 35 shows achievement on Rubric 2c. More than one-half of interviewees scored on the high end of the continuum (51 percent scored at "3 – Developing" or "4 – Accomplished"), and almost one-half scored at the low end (49 percent scored at "1 – Below Beginning" or "2 – Beginning").

TABLE 35

SCORES ON RUBRIC 2C BY GROUP

	TREATMENT
RUBRIC LEVELS (*n* = 82)	%
4 – Accomplished	24
3 – Developing	27
2 – Beginning	34
1 – Below Beginning	15

IMPACT 3

RUBRIC 3A (EXHIBITION)

Rubric 3a describes the continuum on which C/C understand that knowledge about mammoths is based on evidence (see Table 36). It applies to treatment interviewees only.

TABLE 36

CRITERIA AND EXAMPLES FOR RUBRIC 3A (EXHIBITION)

	1 - Below Beginning	2 – Beginning	3 – Developing	4 – Accomplished
Criteria	C/C does not know how knowledge about mammoths is developed.	C/C will describe knowledge about mammoths simply as known information (e.g., "Because scientists say so"), or refer to a secondary source like an educational video, textbook, or lecture without citing evidence.	C/C acknowledge that evidence is used to develop knowledge about mammoths but is unsure of the specifics (e.g., "Scientists use fossils to know what mammoths were like.").	C/C are able to accurately and specifically describe how evidence was used to develop knowledge about mammoths (e.g., "Scientists use fossilized dung and teeth shape to figure out what mammoths ate, dating of rocks tells them how long ago mammoths lived).
Example	It is fascinating how hard their tusks were; how nice and shiny and smooth. (So how do we know that to be true about mammoths?) I've seen, like their size. I guess, I just trust in the organization. [female 43 and female 9]		(And how do you know that's true about mammoths?) Caregiver: We know the layers of the, how do the layers go? How does a fossil form, you know that one? First what? Child: First, the dinosaur dies or mammoth dies, then the bones sink to the bottom of the river or the dirt. And then dirt covers it up and stone, then a bone might be peeking out the dirt. So then when the scientist finds it, he digs and then he finds a bone or a complete skeleton well preserved. Ault: And sometimes it's not a scientist, it's a person that found. Remember the man who found it [Lupe]? Child: Yeah. Caregiver: He was walking with what with his dog? Child: With his dog. And like me, I found it on the beach. [female 33 and female 7]	

Table 37 shows achievement on Rubric 3a. About two-thirds of interviewees scored at the low end of the continuum (66 percent scored at "1 – Below Beginning" or "2 – Beginning"), and about one-third scored at the high end (35 percent scored at "3 – Developing" or "4 – Accomplished").

TABLE 37

SCORES ON RUBRIC 3A BY GROUP

	TREATMENT
RUBRIC LEVELS (*n* = 76)	%
4 – Accomplished	7
3 – Developing	28
2 – Beginning	40
1 – Below Beginning	26

IMPACT 4

RUBRIC 4A (ACTIVITY)

Rubric 4a describes the continuum on which caregiver asks questions that facilitate children's learning based on observations (scaffolding) while working to identify an unknown object (see Table 38).

TABLE 38

CRITERIA AND EXAMPLES FOR RUBRIC 4A (ACTIVITY)

	1 - Below Beginning	2 – Beginning	3 – Developing	4 – Accomplished
Criteria	Caregiver does not engage in scaffolding to help their child identify the object. Caregiver may not ask questions or only asks yes or no questions like, "Do you think this is a fossil?."	Caregiver begins to engage in scaffolding to help their child identify the object. Caregiver mostly asks "What is that?" or other close-ended questions related to identification. The caregiver may also ask leading questions.	Caregiver engages in some scaffolding. Caregiver mostly asks questions like, "Why?" or "What happens if…?" The questions go beyond, "What is that?" but do not broach the idea of "How do you know that?"	Caregiver skillfully engages in scaffolding. Caregiver mostly asks questions like, "Why?" or "What happens if…?" Caregiver also asks questions like, "How do you know?" The questions ask for possible explanations or build on explanations given.
Example	I'd like you to look at this object together and discuss what you think this is.) Caregiver: Okay, that looks like fossil to mommy, what do you think sweetie pie? Child: It look like a fossil. [female 38 and female 4]		Caregiver: So what do think that is? Child: Like a ribcage. Caregiver: A ribcage, why do you think it's a ribcage? Child: Because here it look like ribs. Caregiver: Okay. What if we hold it a different way? Does that still look like a rib cage? Child: No. Caregiver: No? What do you think it looks like? Child: It looks like a bones is and sort of. [male 31 and female 7]	

Table 39 shows achievement on Rubric 4a. More than three-quarters of interviewees scored at the low end of the continuum (81 percent scored at "1 – Below Beginning" or "2 – Beginning"), and about one-fifth scored at the high end (19 percent scored at "3 – Developing" or "4 – Accomplished").

TABLE 39

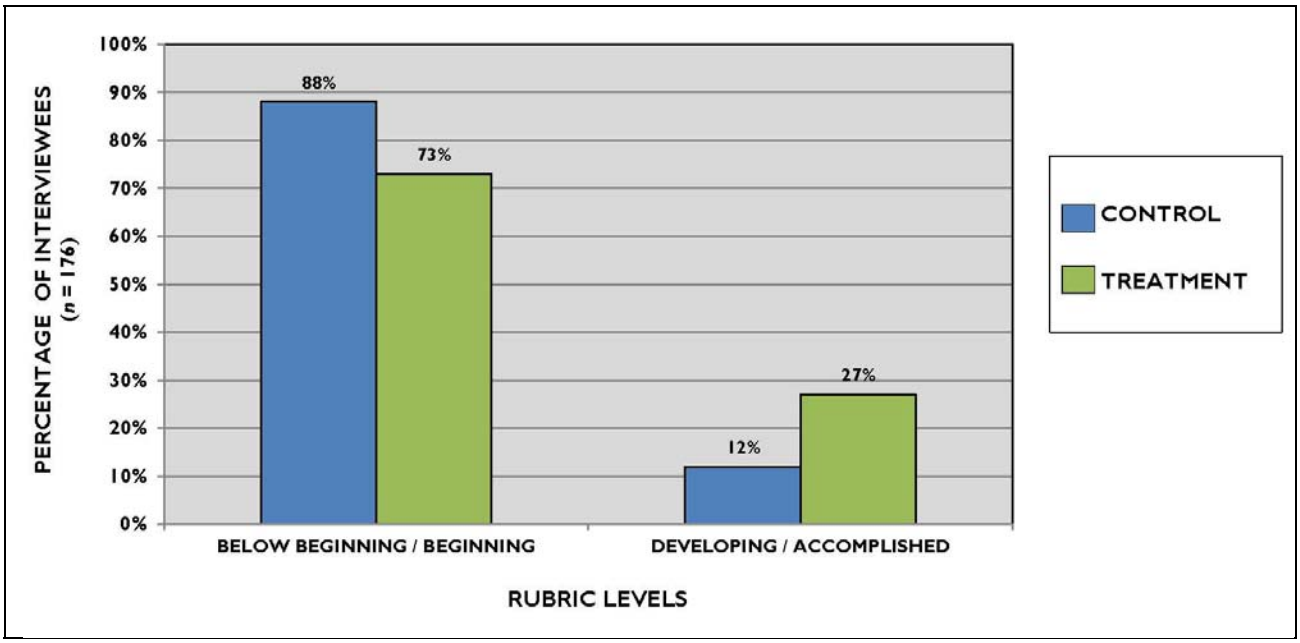
SCORES ON RUBRIC 4A BY GROUP

	GROUP		
	CONTROL	TREATMENT	TOTAL
RUBRIC LEVELS (*n* = 176)	%	%	%
4 – Accomplished	4	7	6
3 – Developing	7	20	13
2 – Beginning	29	28	28
1 – Below Beginning	60	45	53

More treatment than control interviewees scored at the high end of the continuum (27 percent versus 12 percent), and the difference is statistically significant (see Figure 1).

FIGURE 1

ACHIEVEMENT ON RUBRIC 4A (ACTIVITY)



[1]$\chi^2 = 6.578$; *df* = 1; p = .010 (Chi-square)

RUBRIC 4B (EXHIBITION)

Rubric 4b describes the continuum on which the caregiver describes exploring collaboratively with his/her child in the exhibition (see Table 40). It applies to treatment interviewees only.

TABLE 40

CRITERIA AND EXAMPLES FOR RUBRIC 4B (EXHIBITION)

	1 - Below Beginning	2 – Beginning	3 – Developing	4 – Accomplished
Criteria	Caregiver describes sitting on the sidelines or stepping back and letting their child explore on his/her own or with another child. Caregiver acts as an observer.	Caregiver describes providing no more than physical assistance as necessary and answering questions generated by the child. Caregiver acts as an assistant.	Caregiver describes coaching his/her children in the exhibition, explaining how to do an activity or interpreting the information for his/her child, but does collaborate with his/her child. Caregiver acts as a teacher.	Caregiver describes actively engaging both physically and verbally with his/her children, having discussion and using the activities with his/her children. Caregiver acts as a collaborator.
Example	(And how did you help your child while she was doing the activities?) Caregiver: I just kind of let her do her thing, let her take it all in. [female 36 and female 4]		Caregiver: I covered a fossil so she could dig it up. Child: I dug; I discovered it. Caregiver: I made sure she went around every exhibit. We had a fun time playing with the little wooden puppets. So the other little kids were coming to the side because they were watching our puppet show. Child: And they gave us lots of comments. Caregiver: Mmm, compliments. What else. I helped her with the weight station. [female 33 and female 7]	

Table 41 shows achievement on Rubric 4b. Almost two-thirds of interviewees scored at the low end of the continuum (64 percent scored at "1 – Below Beginning" or "2 – Beginning"), and about one-third scored at the high end (36 percent scored at "3 – Developing" or "4 – Accomplished").

TABLE 41

SCORES ON RUBRIC 4B BY GROUP

	TREATMENT
RUBRIC LEVELS (*n* = 78)	%
4 – Accomplished	8
3 – Developing	28
2 – Beginning	37
1 – Below Beginning	27

SUMMARY OF KEY FINDINGS

- Scores on rubrics related to Impact 1 indicate that the majority of children and their caregivers engaged in scientific thinking in the exhibition. However, there were no differences in how control and treatment groups demonstrated scientific thinking skills when identifying an unknown object.

- Scores on rubrics related to Impact 2 indicate that the majority of children and their caregivers felt like they were engaging in a process similar to scientists in the exhibition. However, there were no differences in how control and treatment groups felt like scientists when identifying an unknown object.
- Scores on the rubric related to Impact 3 indicate that the majority of children and their caregivers did not leave the exhibition knowing that knowledge about mammoths is based on evidence.
- Scores on rubrics related to Impact 4 indicate that the treatment group was significantly more likely to scaffold their child's experience identifying an unknown object than the control group.

APPENDICES

APPENDIX A: TIMING AND TRACKING OBSERVATION FORM

REMOVED FOR PROPRIETARY PURPOSES

APPENDIX B: DESCRIPTION OF EXHIBIT SPECIFIC AND SCIENCE SKILL BEHAVIORS OBSERVED BY EXHIBIT

Exhibit	Behavior	Example of What the Behavior Looks Like
Who found these fossils?		
Imagine when Mammoths roamed this valley	Back and forth movement	Shifts body back and forth while looking at hologram, trying to see the different views.
Where were these fossils discovered?		
Compare teeth	Points	Points to exhibit. Includes pointing to specimens behind glass wall.
	Touches	Touches teeth samples
	Looks back and forth	Looks back and forth between teeth samples
	Measures size	Uses hands or other gauge to measure and compare sizes of teeth
	Feels back and forth	Feels back and forth between teeth samples
	Grinds own teeth	Grinds own teeth
	Looks in mirror at own teeth	Picks up mirror and looks in mirror at own teeth
	Looks at other person's teeth	Looks at another person's teeth
Can you find the molars? /Ask questions	Points	Points to exhibit. Includes approaching skull from either side of island.
	Touches	Touches skull. Includes approaching skull from either side of island.
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit. Includes approaching skull from either side of island.
Try making a whole bone out of the pieces here	Points	Points to exhibit
	Touches	Touches bones
	Looks back and forth	Looks back and forth between bones and/or pictures
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
	Feels to put together	Feels bone pieces and reorients shapes to piece together
Notice patterns	Points	Points to exhibit
	Touches	Touches sample
	Looks at more than one sample	Looks at more than one sample under microscope
	Adjusts microscope	Adjusts microscope
	Views other sample	Views a sample other than those provided at exhibit (own belonging, body part, component from other exhibit)
Looks for Tiny Clues	Points	Points to exhibit
	Touches	Touches the bones/fossils
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
	Uses tool	Uses tool to uncover bones/fossils
	Measures size	Uses hands, tool or other gauge to measure the size of the bones/fossils
	Says either "scientist," "paleontologist," or	Says either "scientist," "paleontologist," or "archeologist"

Exhibit	Behavior	Example of What the Behavior Looks Like
	"archeologist"	
Spin movie		
Focus on details	Points	Points to exhibit
	Touches	Touches the bones/fossils
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
	Uses tool	Uses tool to uncover bones/fossils
	Measures size	Uses hands, tool or other gauge to measure the size of the bones/fossils
	Says either "scientist," "paleontologist," or "archeologist"	Says either "scientist," "paleontologist," or "archeologist"
Tell a story		
Observe carefully	Points	Points to exhibit
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
	Systematically uses	Systematically moves cylinder, pausing and looking inside.
How does something become a fossil?	Points	Points to exhibit
	Touches	Touches layer
	Looks back and forth	Looks back and forth between layers at exhibit. May do this while pointing or following another's pointing.
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
Take a closer look/What type of bone is this?	Points	Points to exhibit
	Presses button	Presses button at exhibit
	Looks back and forth between skull and turnable skull	Looks back and forth between real skull and turnable skull
Dissect evidence	Points	Points to exhibit
	Looks back and forth	Looks back and forth between exhibit components: poop sample, plant sample and/or real plants outside
	Uses magnifying glass	Looks through magnifying glass. Does not include simply moving the glass without looking into it.
What is hidden?	Points	Points to exhibit
	Systematically uses	Manipulates sphere systematically, turning it, pausing and looking.
	Says "skate," "rollerkate," "rollerblade"	Says "skate," "rollerkate," "rollerblade"
Mammoth News		
What does a bone's size tell us?	Points	Points to exhibit
	Touches	Touches bone
	Looks back and forth	Looks back and forth between exhibit components (between bones, bones and own bone, shadows. does not include looking at what shadow results from placing a bone)
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
	Systematically changes shadows	Move bone varying distances from the wall, pausing to look at or point to the shadow
	Looks at own/other's shadow	Looks at own or another person's shadow

Exhibit	Behavior	Example of What the Behavior Looks Like
	Says animal name	Says a name of an animal. Could be the wrong name for the shadow that appears
Sit & compare your thigh bone to a mammoth's/Measure bones	Points	Points to exhibit
	Looks back and forth	Look back and forth between mammoth leg and own/other person's leg
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
	Measures size	Use hand, ruler or other gauge to measure size of mammoth or person's leg
	Sits and stretches out leg	Sits at exhibit and stretches out leg
	Observes another	Observes another person sit at exhibit and stretch out leg
	Indicate size of mammoth	Indicates size of mammoth using hand gestures
Make a model	Points	Points to exhibit
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
Study modern examples	Points	Points to exhibit
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
	Turns over pictures	Turns over pictures
	Touches own bones	Touches/feels own bones
	Look of surprise	Look of surprise when looking at pictures (eyes widen, eyebrows raised, mouth may open)
	Says "wow"	Says "wow"
Solve mysteries	Points	Points to exhibit
	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
	Measures size	Uses hand or other gauge to measure size of bones
	Touches own bones	Touches/feels own bones
	Turns exhibit around	Turns around lazysusan/exhibit while looking at it
	Walks around exhibit	Walks around exhibit while looking at it
Mammoth puzzle	Compares to other exhibit	Looks back and forth between this exhibit and another exhibit
Compare	Systematically uses	Place each piece one at a time, pause & look at scale
	Compares weights in hands	Places pieces in each hand, looking back & forth between each hand &/or slightly moving each hand as if a scale for the pieces
Computer kiosks		
Imagine the past/Shadow puppets	Systematically changes shadows	Move puppets varying distances from the screen & pausing to look at or point to the shadow

APPENDIX C: COLLAPSED SCIENCE PROCESS SKILL CATEGORIES AND EXHIBIT BEHAVIORS ACROSS EXHIBITS

SCIENCE PROCESS SKILL	CHILD BEHAVIOR	EXHIBITS WHERE BEHAVIOR IS OBSERVABLE
Observing	Points	Compare Teeth Can You Find the Molars? /Ask Questions Try Making a Whole Bone Out of the Pieces Here Notice Patterns Looks for Tiny Clues Focus on Details Observe Carefully How Does Something Become a Fossil? Take a Closer Look/What Type of Bone is This? Dissect Evidence What is Hidden? What Does a Bone's Size Tell Us? Sit & Compare Your Thigh Bone to a Mammoth's/Measure Bones Make a Model Study Modern Examples Solve Mysteries
	Touches	Compare Teeth Can You Find the Molars? /Ask Questions Try Making a Whole Bone Out of the Pieces Here Notice Patterns Looks for Tiny Clues Focus on Details How Does Something Become a Fossil? What Does a Bone's Size Tell Us?
	Turns exhibit around	Solve Mysteries
	Walks around exhibit	Solve Mysteries
Comparing	Back & forth movement	Imagine When Mammoths Roamed This Valley
	Looks back and forth	Compare Teeth Try Making a Whole Bone Out of the Pieces Here How Does Something Become a Fossil? Dissect Evidence What Does a Bone's Size Tell Us? Sit & Compare Your Thigh Bone to a Mammoth's/Measure Bones
	Feels back and forth	Compare Teeth
	Looks in mirror at own teeth	Compare Teeth
	Grinds own teeth	Compare Teeth
	Looks at other person's teeth	Compare Teeth
	Looks at own/other's shadow	What Does a Bone's Size Tell Us?
	Compares weights in hands	Compare
	Looks at more than one sample	Notice Patterns
	Views other sample	Notice Patterns
	Touches own bones	Study Modern Examples Solve Mysteries

SCIENCE PROCESS SKILL	CHILD BEHAVIOR	EXHIBITS WHERE BEHAVIOR IS OBSERVABLE
Using Different Tools	Adjusts microscope	Notice Patterns
	Uses tool to uncover bones	Looks for Tiny Clues Focus on Details
	Uses magnifying glass	Dissect Evidence
Taking Measurements	Measures size	Compare Teeth Looks for Tiny Clues Focus on Details Sit & Compare Your Thigh Bone to a Mammoth's/Measure Bones Solve Mysteries
Testing/Experimenting	Systematically uses	Observe Carefully What is Hidden? Compare
	Systematically changes shadows	What Does a Bone's Size Tell Us? Imagine the Past/Shadow Puppets

APPENDIX D: DESCRIPTION OF ADULT-CHILD INTERACTION STYLES

Behaviors (check all that apply)	General Description	Example of What the Behavior Looks Like
Adult present	Adult is present with child at exhibit.	Adult is at or right by the exhibit. They may or may not be engaged with the exhibit or the child.
Adult observes	Adult is at the exhibit watching their child. At this moment, they are barely verbally or physically engaging with the exhibit or the child.	Adult stands or sits nearby watching the child. The adult may simply give encouragement ("Good job!") or a reprimand ("Don't throw!") but does not say anything else that is relevant to the exhibit.
Adult coaches	Adult gives verbal and/or physical instruction but doesn't go so far as collaborating and doing the activity with the child	Adult may read the instructions, or tell the child what to do at the exhibit. They may point to something at the exhibit, but then step back. They may demonstrate how to do the activity but then hand the activity completely over to the child to do.
Adult collaborates	Adult and child do the activity together.	The adult may get down to the child's level, adult and child look at each and the exhibit, taking turns or working together to do the activity.

APPENDIX E: TIMING AND TRACKING STATISTICS

DESCRIPTIVE STATISTICS

FREQUENCY DISTRIBUTION

Child's gender (male, female)
Child's age (4-7 yrs., 8-10 yrs.)
Day of the week (weekday, weekend day)
Level of crowding (few, moderate, crowded)
Group (alone, with adults only, with children only, with adults and children)
Adults' gender(male, female)
Adults' ages (18-24 yrs., 25-34 yrs., 35-44 yrs., 45-54 yrs., 55-64 yrs., 65+ yrs.)
Accompanying children's ages (< 4yrs., 4-7 yrs., 8-10 yrs., 11-14 yrs., 15+ yrs.)
Individual exhibits stopped at
Science skill behaviors
Adult-Child Interaction

DESCRIPTIVE AND SUMMARY STATISTICS

FREQUENCY DISTRIBUTION, RANGE, MEDIAN, MEAN, AND STANDARD DEVIATION

Number of adults
Number of accompanying children
Total time spent in the exhibition
Total number of exhibits stopped at in the exhibition
Time spent at individual exhibits

INFERENTIAL STATISTICS

CROSSTABS

Exhibits stopped at by 20 children or more Science skill behaviors Adult-Child Interaction (yes/no in exhibition)	by	Child's gender (male, female) Child's age (4-7 yrs., 8-10 yrs.) Level of crowding (few, moderate, crowded) Group (alone, with adults only, with children only, with adults and children) Adults' gender(male, female) Adults' ages (18-34, 35-54, 55+ yrs.) Accompanying children's ages (< 4yrs., 4-7 yrs., 8-10 yrs., 11-14 yrs., 15+ yrs.)

INFERENTIAL STATISTICS

ANOVAS AND KRUSKAL-WALLIS TEST

Total time spent in the exhibition Total number of exhibit stops Time spent at exhibits stopped at by 20 children or more	by	Child's gender (male, female) Child's age (4-7 yrs., 8-10 yrs.) Level of crowding (few, moderate, crowded) Group (alone, with adults only, with children only, with adults and children) Adults' gender(female adults only, female and male adults, male adults only) Adults' ages (18-34, 35-54, 55+ yrs.) Accompanying children's ages (< 4yrs., 4-7 yrs., 8-10 yrs., 11-14 yrs., 15+ yrs.)

APPENDIX F: VISITOR BEHAVIORS FOR EACH EXHIBIT

	EXHIBIT	EXHIBIT TYPE	# OF VISITORS WHO STOPPED	# OF OBSERVED CHILDREN WHO DISPLAYED EACH BEHAVIOR	# OF OBSERVED CHILDREN & ACCOMPANYING ADULTS WHO DISPLAYED EACH BEHAVIOR
1	Who found these fossils? (entry movie)	Interpretive Support – Video	28		Adult present = 16 Adult observes = 3 Adult coaches = 1 Adult collaborates = 3
2	Imagine when Mammoths roamed this valley (hologram)	Interpretive Support	7	Back & forth movement = 6	Adult present = 1 Adult observes = 0 Adult coaches = 4 Adult collaborates = 2
3	Where were these fossils discovered? (map)	Interpretive Support	3		Adult present = 1 Adult observes = 0 Adult coaches = 0 Adult collaborates = 2
4	Compare teeth	Interactive	47	Points = 7 Touches = 37 Looks back & forth = 9 Feels back & forth = 17 Grinds own teeth = 0 Looks in mirror at own teeth = 0 Looks at other person's teeth = 0 Measures size = 1	Adult present = 10 Adult observes = 4 Adult coaches = 4 Adult collaborates = 16
5	Can you find the molars? /Ask questions	Interactive	21	Points = 4 Touches = 15 Compares to other exhibit = 2	Adult present = 4 Adult observes = 3 Adult coaches = 2 Adult collaborates = 4
6	Try making a whole bone out of the pieces here	Interactive	37	Points = 7 Touches = 27 Looks back & forth = 8 Feels to put together = 18 Compares to other exhibit = 1	Adult present = 7 Adult observes = 4 Adult coaches = 4 Adult collaborates = 13
7	Notice patterns (microscope)	Interactive	34	Points = 10 Touches = 28 Looks at more than one sample = 20 Adjusts microscope = 26 Views other sample = 19	Adult present = 9 Adult observes = 5 Adult coaches = 2 Adult collaborates = 13
8	Looks for Tiny Clues (dig pit)	Interactive	58	Points = 3 Touches = 25 Uses tool to uncover bones = 43 Measures size of bones = 0 Says "scientist," "archeologist," "paleontologist" = 3 Compares to other exhibit = 2	Adult present = 16 Adult observes = 11 Adult coaches = 11 Adult collaborates = 9
9	Spin movie	Interactive	41		Adult present = 10 Adult observes = 10 Adult coaches = 1 Adult collaborates = 12

	EXHIBIT	EXHIBIT TYPE	# OF VISITORS WHO STOPPED	# OF OBSERVED CHILDREN WHO DISPLAYED EACH BEHAVIOR	# OF OBSERVED CHILDREN AND ACCOMPANYING ADULTS WHO DISPLAYED EACH BEHAVIOR
10	Focus on details (dig pit)	Interactive	49	Points = 7 Touches = 21 Uses tool = 40 Measures size = 0 Says "scientist," "archeologist," "paleontologist" = 2 Compares to other exhibit = 1	Adult present = 23 Adult observes = 3 Adult coaches = 2 Adult collaborates = 16
11	Tell a story (story cards)	Interactive	11		Adult present = 3 Adult observes = 2 Adult coaches = 1 Adult collaborates = 2
12	Observe carefully (tube with water & sand)	Interactive	40	Points = 6 Systematically uses = 35 Compares to other exhibit = 0	Adult present = 11 Adult observes = 5 Adult coaches = 3 Adult collaborates = 19
13	How does something become a fossil? (layers)	Interpretive Support	5	Points = 0 Touches = 2 Looks back & forth = 2 Compares to other exhibit = 0	Adult present = 1 Adult observes = 1 Adult coaches = 0 Adult collaborates = 2
14	Take a closer look/What type of bone is this? (real skull)	Interactive	39	Points = 5 Presses button = 7 Looks back & forth between the skull & the turnable skull = 13	Adult present = 17 Adult observes = 3 Adult coaches = 3 Adult collaborates = 9
15	Dissect evidence (poop)	Interactive	38	Points = 9 Looks back & forth = 22 Uses magnifying glass = 32	Adult present = 12 Adult observes = 5 Adult coaches = 1 Adult collaborates = 13
16	What is hidden? (rollerskate)	Interactive	41	Points = 10 Systematically uses = 34 Says "skate," "rollerskate," "rollerblade" =14	Adult present = 11 Adult observes = 4 Adult coaches = 4 Adult collaborates = 14
17	Mammoth News (couch)	Interpretive Support – Reading Area	1		Adult present = 1 Adult observes = 0 Adult coaches = 0 Adult collaborates = 0
18	What does a bone's size tell us? (femur on wall)	Interactive	46	Points = 20 Touches = 31 Looks back & forth = 25 Looks at own/other's shadow = 9 Systematically changes shadows = 37 Says animal name = 20 Compares to other exhibit = 1	Adult present = 4 Adult observes = 6 Adult coaches = 5 Adult collaborates = 27
19	Sit & compare your thigh bone to a mammoth's/Measure bones	Interactive	8	Points = 1 Sits and stretches out leg = 4 Observes another = Looks back & forth = 3 Measure size = 2 Indicates size of mammoth = 0 Compares to other exhibit = 2	Adult present = 2 Adult observes = 1 Adult coaches = 4 Adult collaborates = 0

	EXHIBIT	EXHIBIT TYPE	# OF VISITORS WHO STOPPED	# OF OBSERVED CHILDREN WHO DISPLAYED EACH BEHAVIOR	# OF OBSERVED CHILDREN AND ACCOMPANYING ADULTS WHO DISPLAYED EACH BEHAVIOR
20	Make a model (big mammoth)	Interpretive Support – Model Mammoth	39	Points = 21 Compares to other exhibit = 3	Adult present = 8 Adult observes = 7 Adult coaches = 4 Adult collaborates = 13
21	Study modern examples (xrays)	Interactive	34	Points = 7 Turns over pictures = 27 Touches own bones= 0 Look of surprise = 3 Says "wow"= 2 Compares to other exhibit = 9	Adult present = 7 Adult observes = 5 Adult coaches = 1 Adult collaborates = 14
22	Solve mysteries (unknown skeleton)	Interactive	17	Points = 6 Touches own bones= 0 Turns exhibit around = 7 Walks around exhibit = 5 Measure size of bones = 0 Compares to other exhibit = 0	Adult present = 6 Adult observes = 1 Adult coaches = 2 Adult collaborates = 3
23	Mammoth puzzle	Interactive	32	Compares to other exhibit = 3	Adult present = 7 Adult observes = 4 Adult coaches = 4 Adult collaborates = 14
24	Compare (weight)	Interactive	35	Compares weights in hands = 3 Systematically uses = 23	Adult present = 8 Adult observes = 7 Adult coaches = 2 Adult collaborates = 15
25	Computer kiosks	Interactive	23		Adult present = 10 Adult observes = 4 Adult coaches = 0 Adult collaborates = 6
26	Imagine the past/Shadow puppets	Interactive	55	Systematically changes shadows = 37	Adult present = 10 Adult observes = 15 Adult coaches = 1 Adult collaborates = 24

APPENDIX G: PRE-VISIT INTERVIEW GUIDE (CONTROL)

REMOVED FOR PROPRIETARY PURPOSES

APPENDIX H: POST-VISIT INTERVIEW GUIDE (TREATMENT)

REMOVED FOR PROPRIETARY PURPOSES

APPENDIX I: SCORING RUBRIC

REMOVED FOR PROPRIETARY PURPOSES

APPENDIX J: STATISTICS

DESCRIPTIVE STATISTICS

FREQUENCY DISTRIBUTION

Adult's gender (male, female)
Adult's age (17-24, 25-34, 35-44, 45-54, 55-64, 65+yrs.)
Child's gender (male, female)
Child's age (3-7 yrs., 8-11 yrs.)
Number of adults (1 adult, 2 adults, 3 adults or more)
Number of children (1 child, 2 children, 3 children, 4 children or more)
CDM visitation (first-time, repeat/ once, twice, 3 times, 4 times or more)
Mammoth Discovery! visitation (first-time, repeat)
Scores on Rubric 1a – 4b

DESCRIPTIVE AND SUMMARY STATISTICS

FREQUENCY DISTRIBUTION, RANGE, MEDIAN, MEAN, AND STANDARD DEVIATION

Adult's age
Child's age
Number of adults
Number of children
Number of CDM visits

INFERENTIAL STATISTICS

CROSSTABS

Control/treatment group		Adult's gender (male, female)
Adult's gender (male, female)		Adult's age (17-34, 35-54, 55+yrs.)
Adult's age (17-34, 35-54, 55+yrs.)		Child's gender (male, female)
Child's gender (male, female)	by	Child's age (3-7 yrs., 8-11 yrs.)
Child's age (3-7 yrs., 8-11 yrs.)		CDM visitation (first-time, repeat)
CDM visitation (first-time, repeat)		Scores on Rubric 1a – 4b