Summative Study of
Explore Science: Earth & Space Activity Toolkits

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Figure 1. A facilitator and children peer into a bottle to observe how a laser beam interacts with vapor during the Investigating Clouds activity.

Acknowledgements

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Executive Summary

This is a summative evaluation of the *Explore Science: Earth & Space* activity toolkits produced through the Space and Earth Informal STEM Education (SEISE) project, funded through the generous support of the National Aeronautics and Space Administration (NASA; through cooperative agreements NNX16AC67A and 80NSSC18M0061). The tabletop activities included in the toolkits were designed to be facilitated at informal education sites across the United States in conjunction with ongoing programming, exhibitions, and special events.

The following questions guided our planning for the summative evaluation of the *Explore Science: Earth & Space* activity toolkits.

1) How many people is it estimated that the project reaches annually? How is this distributed among the project's target audiences? How many people might this project reach by the end of the grant and beyond?

2) How do target audiences a) engage with the activities, b) find relevance in them, c) strengthen or explore their science identity, and d) grow in understanding around the four Science Mission Directorate (SMD) content areas (astrophysics, planetary science, heliophysics, and Earth science)?

While a brief overview of the audiences served by the toolkit is presented here, the first evaluation question is more thoroughly addressed in a separate memo about how the evaluation team calculated toolkit reach estimates using data from the annual partner and toolkit report surveys. The SEISE project identifies target audiences for this project as including intergenerational families with children between 6 and 12, school aged children (grades K-5), and several underserved audiences (more about these audiences in Table 8, pg. 14).

The evaluation team addressed the second evaluation question through data collection at 16 partner sites across the country. Each of these sites had received a 2018 *Explore Science: Earth & Space* activity toolkit and many had also received the first available toolkit from 2017. More details about the activities in each of the toolkits can be found in Appendix A. Data collection at these sites included in-person surveys with adults and children, as well as group interviews and observations.

Summary of Findings

1. **Activity toolkits reached underserved audiences and the general population.** When describing who they used the toolkits with, sites reported general descriptions like "families", "caregivers", "local community", and other ways of describing a wide-range of likely museum audience groups. These groups also included underserved audiences, such as low-income or lower socio-economic status audiences (83%, n=248 toolkit recipients), racial and ethnic minorities or communities of color (82%), Spanish-speakers (53%), and non-native English speakers (32%).

2. **Families enjoyed and were interested in the *Explore Science: Earth & Space* activities.**

Almost all adults shared that their groups enjoyed (95%, n=242) and were interested in (95%, n=242) the activities. Most children (86%, n=144) shared that these activities were "really fun."

3. **Families were more interested in and curious about Earth and space topics after trying the activities.**
   Most adults reflected that their groups were *more* interested (85%, n=238) in Earth and space topics after trying the activities, and almost two-thirds of children marked that they were *more* curious (61%, n=142) about Earth and space after trying the activities.

4. **Families reported statistically significant increases in their confidence in talking about heliophysics, Earth science, planetary science, and astrophysics content after using the activities.**
   Almost all adults shared that their groups learned something new at the activities (91%, n=237). When asked to describe what their groups learned, adults in 97% of family groups (n=180) shared ideas in line with the educational goals of the activity toolkits. After trying the activities, adults showed statistically significant increases in confidence ratings around being able to talk about Earth and space ideas related to heliophysics, Earth science, planetary science, and astrophysics.

5. **Earth and space topics were more relevant to families' lives and experiences after trying the activities.**
   Survey data demonstrated that a majority of adult respondents (72%, n=237) felt that Earth & space topics were more relevant after participating in the activities. In addition, when children participants were asked about what the activities reminded them of, a third of their responses (33%, n=120) mentioned something related to Earth & space content, or made specific connections between this type of content and how and where they encountered it in their everyday lives. Adults (n=11) and children (n=1) from family groups were also asked to answer interview questions regarding relevance. Some of those responses indicated increased content understanding and being able to relate content to specific examples from their everyday life.

6. **Families reported being able to look closely, use their imaginations, choose and explore ideas in hands-on ways, work together, and share discoveries at the activities.**
   Families reported engaging in behaviors that the project team considered useful for exploring or supporting a science identity. Children and adults reflected that they were able to do something hands-on to learn more (73%, n=143; 89%, n=239, respectively), look at something closely (61% and 81%), play and use their imaginations (60% and 71%), share a discovery (53% and 72%), choose ideas to explore (52% and 64%) and work together with their groups (50% and 60%) "a lot". This was also supported by observation and interview data.

Introduction

Project Overview
The National Informal STEM Education Network (NISE Net) is a community of informal educators and scientists who are dedicated to supporting learning about science, technology, engineering, and math (STEM) across the United States. They work to build the capacity of informal science education institutions and research organizations to work together to raise public awareness, understanding, and engagement with current topics in science.

In 2015, they were awarded funding from the National Aeronautics and Space Administration (NASA) to create educational products and support informal educators' professional development in engaging the public with Earth and space content (through cooperative agreements NNX16AC67A and 80NSSC18M0061). Through this funding, the Space and Earth Informal STEM Education (SEISE) project is in the process of creating numerous professional development workshops and additional supports for informal educators. They will also create over 50 copies of a 600 ft^2 exhibition and over 1000 activity toolkits for distribution to their partners at no cost to those institutions. At the time of this evaluation, two distinct toolkits had been developed and 250 copies of each were shared with partners. Two additional toolkits are planned, with an additional 350 copies of each planned for distribution in the near future.

This evaluation focuses on the impacts of the *Explore Science: Earth & Space* activity toolkits on the public. For details about the specific activities available to the public during the evaluation, please see Appendix A.

Creating the Explore Science: Earth & Space activities
The SEISE project team had several goals and guiding ideas that helped them shape the development of the *Explore Science: Earth & Space* activities.

These included creating toolkits that:

- aligned with the four content areas of NASA's Science Mission Directorate (SMD): astrophysics, Earth science, heliophysics, and planetary science, and
- fostered rich experiences for informal learning environments, like museums (Ostman, 2016)

The SEISE project created a learning framework inspired by the six strands of science learning developed by the National Research Council (2009). Based in research, this document described key ideas, questions, and ways of experiencing content that would help visitors to learn, engage, and grow in informal science environments like those served by the SEISE project. The learning framework included three main ideas, as provided here, with several sub-points that helped to illustrate them (see Appendix B). The learning framework stated that visitors would:

1) Experience Earth and space PHENOMENA and explore scientific discoveries.
2) Use the scientific PROCESS and reflect on science as a way of knowing.
3) PARTICIPATE in the scientific community and identify as a science learner.

A content map also guided the development of the *Explore Science: Earth & Space* toolkits and included several big ideas that were explicitly linked to NASA's four Science Mission Directorate (SMD) content areas. These ideas were incorporated to different extents in the development of the activities in each toolkit. The main points of the content map are presented below, followed by brackets indicating each of the related SMD content areas. A more detailed content map with content sub-points is included in Appendix C.

- The sun powers Earth and our solar system. [heliophysics]
- Earth is a changing planet of air, water, rock, and life. [Earth science]
- Planetary systems like ours may contain water and life. [planetary science]
- Forces and energy connect everything in the universe. [astrophysics]
- The universe is very large, old, and mysterious. [astrophysics]
- Our society chooses to explore Earth and space.

Finally, the project team conceptualized the exploration of science identity as drawing from visitors' feelings of engagement and interest in their experiences with the activities and whether or not they felt that they had engaged like a scientist. The team felt that being able to observe real phenomena, ask questions, come up with creative ideas to explore, doing something hands-on to learn more, working with others, and sharing discoveries were all things that visitors might do when engaging with multiple toolkit activities and were all related to the work that scientists do every day (see Table 1).

Table 1. How family actions at activities may be related to the actions of scientists.

What a scientist might do	Related actions we might see families doing at the activities
Observe unexplained phenomena	Look at something closely
Try to learn more through imagination or access to others' findings	Use their imagination Work together
Try to learn more through direct exploration or testing phenomena, by themselves or with others	Choose ideas to explore Do something hands-on Work together
Note what was learned and share with others	Work together Share a discovery

The evaluation team used these documents and conversations with the project team to create evaluation questions and instruments that were grounded in the specific realities and goals of the project.

Evaluation Questions

The following questions guided our planning for the summative evaluation of the *Explore Science: Earth & Space* activity toolkits.

1) How many people is it estimated that the project reaches annually? How is this distributed among the project's target audiences? How many people might this project reach by the end of the grant and beyond?

2) How do target audiences a) engage with the activities, b) find relevance in them, c) strengthen or explore their science identity, and d) grow in understanding around the four SMD content areas (astrophysics, planetary science, heliophysics, and Earth science)?

Methods

Overview

In order to address question 1 (see above), we collected information through the 2017 & 2018 reporting surveys, which were sent to all recipients of the activity toolkits. In these surveys, respondents report details about when and how they used the toolkits, as well as how many members of the public were served through their programming and which underserved audiences they felt were reached by their programming with the toolkits. We also garnered data about toolkit usage in the annual partner survey, which is administered later in the year (fall as opposed to early summer) and allows toolkit recipients to reflect on toolkit usage and who was served by their programming over a longer time-span. While a brief overview of the audiences served by the toolkit is presented here, the first evaluation question detailing reach estimates and their calculation is more thoroughly addressed in a separate memo.

The second question was addressed through observations, surveys, and interviews with visitors at 16[1] sites across the United States (see Figure 2). After family groups had tried three or more kit activities and were leaving the activity area, they were approached and asked to respond to brief surveys depending on their age – one version was made available for adults and another for children five and up. These surveys included open-ended questions about relevance and learning, and close-ended questions around engagement, interest, what the groups felt they were able to do at the activities, and learning. A subset of adults and children were also interviewed about their experiences and their responses to the surveys, to provide additional information about their responses and more directly address ways in which they may have explored or strengthened their science identity. Finally, a subset of families was also observed using the activities so that we could understand and describe how families engaged with the products.

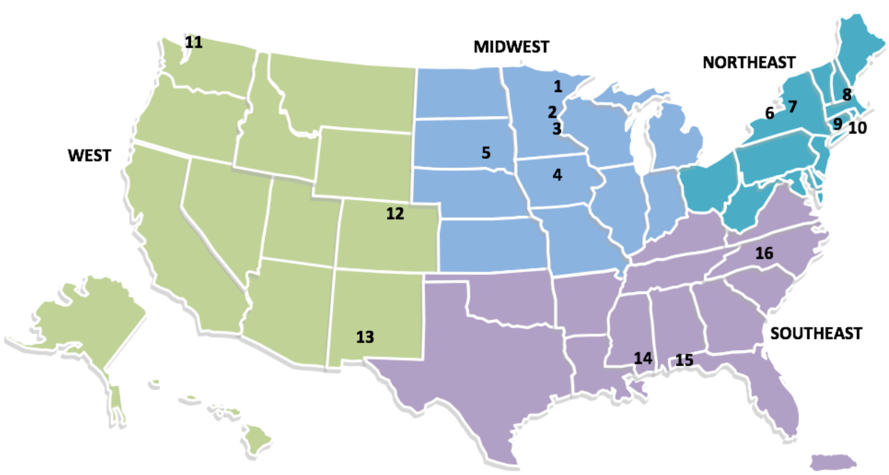

Figure 2. Regional distribution of data collection sites. *Numbers 1-10 are sites where SMM and MOS collected data, while numbers 11-16 represent sites that collected their own data.*

[1] The sixteen sites included the Bakken Museum, Duluth Children's Museum, Pensacola MESS Hall, Imagine Children's Museum, Las Cruces Museums, Science Museum of Minnesota, Sciencenter, Washington Pavilion, Lynn Meadows Discovery Center for Children, Stepping Stones Museum for Children, Discovery Place, Science Center of Iowa, Children's Museum at Holyoke, MiSci: Museum of Innovation and Science, Discovery Museum and Planetarium, and the University of Colorado Boulder.

Data Collection Sites

Site Recruitment

Potential sites were identified through the review of application materials and conversations with SEISE project leadership. Our goal was to draw from a range of museum types, sizes, and regions served by the project. To be a good fit for the study, a potential site would be facilitating 3 or more activities and expect several family groups with elementary aged children. If they were located within driving distance of the evaluation teams in Minnesota or Massachusetts, trained evaluators would attend the programming and collect data. If not, the evaluation team would ask sites if they would be willing to have their own staff or volunteers collect data at their events. As training for these sites, data collectors took an online human subjects training course, read a data collection protocol, reviewed the instruments, and then participated in a phone-call training with the evaluation team to review the process, talk through what this would look like at each site, and answer questions.

Data Collection Sites

Data collection sites (16 total) varied in terms of size, type of institution, and the four geographic locations served by the NISE Network (see Table 2). Specifically, five sites were located in the Midwest, five in the Northeast, three in the Southeast, and three in the West (see Figure 2). Sites self-identified their institution type and annual budget range in their application materials. Institution size was determined using the Association of Science and Technology Centers' (ASTC's) designations around organization size with annual budgets of up to $1 million being "very small", over $1 million and less than $2.5 million as "small", over $2.5 million and less than $6.5 million as "medium", and $6.5 million or more as "large". Sites were located in small to medium-sized urban cities, and reported annual visitor attendance ranging from 5,000 to 1.4 million people (ASTC Sourcebook, 2017).

Table 2. Data collection site overview.

Descriptors	Details	Total Sites
Region	MW	5
	NE	5
	SE	3
	W	3
Museum Type	Science Museums	10
	Children's Museums	6
Organization Size	Very small	7
	Small	5
	Medium	2
	Large	2

Events at the Sites

One of the requirements of receiving a toolkit was that recipients would feature the activities at an event. "Event" was interpreted broadly by toolkit awardees and toolkit activities were often integrated into already scheduled offerings in the Spring and Summer of 2018, like Family Science Saturday, Earth & Space Science Day, Earth Day, Astronomy Day, or Family Science Saturday. They were usually not designated as special *Explore Science: Earth & Space* days. The *Explore Science: Earth & Space* activities were part of larger programmatic efforts around these themes and tended to be placed together in a central area at most data collection sites. For more context about the range of programming at data collection sites, see Appendix D, which features vignettes describing programming and data collection at two sites in more detail.

Most activities (89%, n=109) out on the floor during data collections were from the 2018 toolkit and 11% (n=14) of activities were from the 2017 toolkit (see Appendices A & G for more about the toolkits, their representation at data collection events, and their connection to the SMD content areas). An average of six activities were available during the data collection periods.

Visitor attendance varied across sites, as did the day and times of collections. Data collectors were asked to provide a general sense of how busy the site was during event programming. Most sites (58%, n=19 data collection events) reported moderate levels of visitors; indicated by many people being in the space, but visitors still being able to walk without being impeded. Five sites (26%) reported low attendance, where there were not many people and visitors were very unlikely to bump into someone. Three sites (16%) noted high visitor attendance, where it was crowded and visitors would need to step out of each other's way to move around the gallery space.

Data Collection Methods

Our methods included observations of intergenerational groups interacting with the activities, adult and child surveys, group interviews, and event description forms filled out by data collectors. For all methods, we approached intergenerational groups that included at least one adult and at least one child who appeared between the ages of 5 and 12. Multiple members of the same groups were sampled to provide both individual feedback and a better understanding of the group's experience as a whole. In cases where we asked multiple adults to reflect on their group's experience, we included each of their responses in our analysis. We felt it was important to treat their responses equally, though multiple adults in a group may have a different perspective about their group's experience. We also recognize that intergenerational groups may be composed of individuals with different kinds of relationships to each other, including those who are related, friends, or caretakers; people who may feel close or estranged; and groups that may see each other often or practically never. However, as shorthand, we use the term "family" in this report to share the data we collected from intergenerational groups.

Group observation and interview data, as well as adult and child surveys, were collected by trained evaluation staff from the Museum of Science, Boston (MOS) and the Science Museum of Minnesota (SMM) at several sites. Staff and volunteer data collectors at sites distant from MOS and SMM were trained to collect adult and child surveys, only.

Data were collected from 180 family groups, which included surveys from multiple adults and children within groups at times, for a total of 242 adult surveys, 147 child surveys, 35 group observations, and 15 group interviews (see Table 3).

Table 3. Overview of data collected from the public.

Type of data collected	# Collected
Adult surveys	242
Child surveys	147
Group observations	35
Group interviews	15

Adult and Child Surveys

As family groups left the activity area, data collectors asked adults screener questions; if they had had a chance to try any Earth and space activities, and if so, how many and which ones. Adults could indicate the activities by pointing to them, describing them, and referencing a double-sided reference sheet that had color photos of each of the possible activities. If their group had visited three or more activities[2], data collectors recruited them to fill out surveys.

Each group member was given a survey; adults were given a survey with questions about their own experiences, as well as their group's experience. During analysis, all closed ended adult responses about their group's experience were included, even if they provided different ratings, in order to respect each adult's unique perspective and come closer to better representing the group's experience. The open-ended question about what the group may have learned was analyzed by combining all adult responses for a group, coding this, and then reporting codes by percentage of groups.

Children were also given a survey asking about their own experiences that was created at a second-grade reading level. Data collectors or group members often helped young children (5-9 year olds) to fill out their surveys. Children younger than 5 were not asked to fill out a survey. Adult and child surveys had close-ended questions about enjoyment, interest, curiosity, what they were able to do at the activities, relevance, and learning. Open-ended questions around learning and relevance were also included. See Appendix E for adult and child instruments used in the evaluation.

Group Observations

Before changes were made to our protocol (see Limitations section below), a data collector began observing a group as they entered the activity area if they had at least one adult and at least one child who appeared to be between the ages of 5 and 12. The purpose of the group observation was to understand if families were using the activities as intended; in ways that a scientist might engage in the processes of her work. We observed how often adults and children seemed to look at something closely, play or use their imagination, explore an idea, do something hands-on, or share a discovery at each of the activities that they chose to visit. We attempted to be conservative in our estimates of observed behaviors. For example, we only counted "looked at something closely" when an adult or child appeared to be reading supplemental information at the activity or was peering closely at a phenomena for more than three seconds. For example, a child drawing an alien at an activity would not be considered "looked at something closely", because they were not observing phenomena like a scientist might; whereas a child watching craters form as objects are dropped in the sand would be coded for this behavior. See Appendix E for the observation instrument and Appendix F for more detail about how we defined each of these behaviors for the observations.

Group Interviews

Again, before changes were made to our protocol, groups were asked to participate in an interview immediately following the surveys. This method was used to expand on some of the questions in the survey instruments that addressed interest, confidence, relevance and science

[2] Most data collected and analyzed was from visitors who had tried three or more activities. However, in some locations with less visitation, the protocol was altered to allow visitors who had stopped at one or more activities to participate. A total of 20 adult responses (out of 242 surveys) were included from visitors who had stopped at only one or two activities in order to take advantage of a larger dataset.

identity, with respect to participating in the *Explore Science: Earth & Space* activities. See Appendix E for the group interview instrument.

Event Description Forms
Data collectors at each event used an event description form to capture basic information about programming; which activities were out on the floor, how they were being facilitated and by whom (volunteers, staff, high school students, etc.…), the time and date of the event, crowding levels during the event, layout of the activities, and the proximity of other related Earth and space content, as well as insights about data collection challenges that they may have encountered. See Appendix E for the event description form instrument.

Limitations

It became clear during early data collection that obtaining a large amount of observational and interview data would lead to a low overall sample size. This was due to long dwell times of observed groups (some groups were spending over a half hour, meticulously trying each of the activities) and short windows of collection opportunity (we could only collect data during programming, which tended to span about four hours on a given day). So, after collecting data at a few events, we changed our plans to collect fewer observations and interviews that would help illumine close-ended responses and focused on increasing our collection of the more quantitative survey data. During analysis, we decided to exclude observational data, as our sample size was too small to provide additional context to the results. We have chosen to include interview data, however, because each person's comments help provide a better representation of their experiences.

Also, as the evaluation team moved forward with data collection across different sites, asking the screener questions proved time-consuming and cumbersome, especially for non-evaluation staff. We decided to add a question to the survey instrument that asked about the number of activities the group had tried instead. We included all surveys in our analysis, though 20 out of 242 adult surveys were from visitors who reported trying out only one or two activities.

Respondent Demographics

Demographic data were collected from 148 adult survey respondents. Adult survey respondents were asked to report their own race or ethnicity and gender, and the ages of people in their group. The majority of groups were small; three fourths of the groups had 2-3 people. One fifth of groups had 4-5 people, and only a few groups had 6 or more people (see Table 4).

Table 4. Group size as reported by adult respondents. (n=148)

Group size	% of groups
2-3 people	76%
4-5 people	20%
6 or more people	4%

Adults were also asked to report the ages of people in their groups, which were mostly composed of children between the ages of five and twelve (see Table 5). Over half of the group members ranged in age from five to twelve, and close to three out of ten group members were adults aged eighteen and older.

Table 5. Group members' ages as reported by adult respondents. (n=493)

Age	% of participants
4 and under	14%
5-7	26%
8-12	31%
13-17	3%
18-29	2%
30-39	11%
40-49	7%
50-59	3%
60-69	3%
70-79	1%
80 and up	<1%

Adult respondents were asked to identify their own gender; this was skewed towards female in our sample (see Table 6). Two thirds of adult respondents stated they were female, one third stated they were male, and less than one percent stated they fit into another category.

Table 6. Gender of adult respondents. (n=213)

Gender	% of adult respondents
Female	66%
Male	33%
Another category	<1%

Adult respondents were also given the option to report their own race or ethnicity. Most respondents identified as White, while about one out of ten identified as Asian, Hispanic or Latino, or Black or African American. A handful of respondents identified as American Indian or Alaska Native, Native Hawaiian or Pacific Islander, or other (see Table 7).

Table 7. Race or ethnicity of adult respondents. (n=203)

Race or ethnicity	% of adult respondents
White	72%
Asian	11%
Hispanic or Latino	10%
Black or African American	9%
American Indian or Alaska Native	3%
Native Hawaiian or Pacific Islander	1%
Other	1%

Findings

Finding 1: Activity toolkits reached underserved audiences and the general population.

We will discuss the total number of the general public reached through a separate memo explaining our methods, calculations, and estimates. It will include toolkit report data from all years of the project.

Reaching underserved audiences
Sites reported which of several specific underserved audiences (as defined by the project team) were reached by their activity toolkit programming in the 2018 toolkit report survey (n=248, see Table 8)). Almost all sites (90%) reported serving girls with the toolkits, and most also reported serving low-income visitors (83%) and communities of color (82%). Only one in five toolkit recipients (20%) reported serving American Indians or Alaskan natives.

Table 8. Underserved audiences reached by the toolkits. (n=248)

Underserved Audience	% of respondents
Girls	90%
Low-income / Lower socio-economic status	83%
Racial and ethnic minorities / communities of color	82%
Spanish speaking audiences	53%
Rural	48%
Inner city	41%
Disabled / Differently abled	40%
At-risk youth	34%
Other non-native English speakers	32%
American Indian / Alaska Native	20%

Finding 2: Families enjoyed and were interested in the *Explore Science: Earth & Space* activities.

Interesting and enjoyable activities. Almost all adult visitors (95%, n=242) reported finding the activities enjoyable and interesting for their group (see Tables 9 & 10). Half (48%) found the activities "very enjoyable" for their group, half (48%) found the activities "enjoyable", a handful (4%) found the activities "a little enjoyable", and <1% rated the activities as "not enjoyable".

Table 9. How enjoyable adults found the activities for their group. (n=242)

Enjoyment rating	% of adult respondents
Very enjoyable	48%
Enjoyable	48%
A little enjoyable	4%
Not enjoyable	<1%

Half (53%) of adult visitors (n=242) reported finding the activities "very interesting" for their group, while two fifths (42%) reported finding them "interesting". A handful of respondents (4%) reported finding them "a little interesting", and 1% reported the activities were "not interesting" for their group (see Table 10).

Table 10. How interesting adults found the activities for their group. (n=242)

Interest rating	% of adult respondents
Very interesting	53%
Interesting	42%
A little interesting	4%
Not interesting	1%

Most children (86%, n=144) shared that the activities were "really fun". Ten percent (13%) of children stated that the activities were "a little fun" and 1% found the activities "not fun" (see Table 11).

Table 11. Children's ratings for the activities. (n=144)

Fun rating	% of child respondents
Really fun	86%
A little fun	13%
Not fun	1%

Finding 3. Families were more interested in and curious about Earth and space topics after trying the activities.

Experiences led to increased curiosity and interest in Earth and space topics. Most adults (85%, n=238) reported that their group was "more interested" in Earth and space topics after trying the activities, with the remainder (15%) reporting "no change" in interest (see Table 12).

Table 12 Adults' reflections on how their groups' interest in Earth and space topics may have changed after trying the activities. (n=238)

Change in interest	% of adult respondents
More interested	85%
No change in interest	15%
Less interested	0%

Close to two-thirds (61%, n=142) of children shared that they were more curious about Earth and space after trying the activities (n=142 (see Table 13). A third (31%) of children shared their curiosity was "about the same", and a handful (8%) of children shared that they were "less curious" about Earth and space after trying the activities.

Table 13. Children's reflections on how their curiosity about Earth and space may have changed after the trying the activities. (n=142)

Change in curiosity	% of child respondents
More curious	61%
About the same	31%
Less curious	8%

In order to better understand how the activities may have led to increased interest or curiosity, we asked groups to tell us more about these ratings. Adult visitors shared that their group's enjoyment led to increased interest, or that the activities had them thinking about Earth and space in different ways.

Adults' responses about their increased interest in Earth and space (n=12)

- She's more interested in the topics now and having lots of fun.
- You know Earth Day; [we are] programmed to think of living things on Earth like plants, but don't think about non-living things. Seeing these [activities] made me think more not just about living things, but the whole thing [Earth].
- It got our group thinking about and realizing how magnets work on the planet. How science works around us.
- How the Earth and solar system work. Like to learn about new things going on in outer space.
- By doing hands-on activities and having them do it, we can look at something later and have it stick more. We can do some things in the future, in different situations.
- This gives them a direction to start thinking about robotics competition. They peak interest!
- Reminded us that it's for everybody. We can learn from kids and teenagers and we can also learn. New info can make you want to learn.
- We'll always like it, but when it comes to showing kids how to make it more interesting for them, that's good.
- She was smiling a lot through it.
- The visualization that we used, we didn't know as much.

- I felt like my kids and I were more interested in the activities. Doing it here where it's small and a small space. The staff were proactive - helping and explaining. Seeing other parents and kids do it, too, was helpful and we had stuff to read.
- Interesting to see how much work goes into everything they've done like the rovers; working out the electricity for that.

Finding 4: Families reported statistically significant increases in their confidence in talking about heliophysics, Earth science, planetary science, and astrophysics content after using the activities.

We created open and closed ended questions to measure what families felt they had learned from the activities.

Families felt they learned something new. Almost all adults (91%, n=237) shared that their group learned something new at the Earth and space activities. A handful of adults (4%) replied that their groups had not learned something new about Earth and space, and about the same number (5%) reported that they were unsure if their groups had learned something or not.

Family learning was in line with main messages and SMD content. We asked adults to share what their groups learned at the activities and almost all of their responses (97%, n=180 family groups) were in line with the main messages of the toolkits. Planetary science and astrophysics content was most prevalent in adults' responses (59% and 58%, respectively) (see Table 14), and were also the most presented at data collection sites (see Appendix G).

Table 14. Adults' open-ended responses about family learning coded by SMD content areas. (n=180)

Content Learned	Response Examples*
Planetary science (59%)	*"Earth's magnetism and how craters are made."* *"Mars Rover transmission times and how planets are measured."* *"Finding planets' mass."* *"Stuff about rock impact for craters."*
Astrophysics (58%)	*"The way size relates to the motion of objects in space."* *"Sun spots are magnetic. 5,000 exoplanets."* *"The earth's magnetic fields protect us from solar flares and create the northern lights."* *"Everything about gravity and magnetic fields."* *"Telescope can be used to view something far way."*
Earth science (26%)	*"About the run off from mountains when it storms."* *"How clouds are made. Magnetic field on earth."* *"Our Earth is magnetic."* *"Air pressure can make a cloud and what happens after a storm."*
Heliophysics (19%)	*"Magnetic fields of the sun."* *"Magnetic fields, solar/sun spots, folding telescopes."* *"Sun spots move and change!"* *"The sun is bigger than the earth (4 years old)."* *"Shifting magnetic fields on the sun. A little about rovers."*

A majority (78%, n=125) of children's responses to the fill in the blank question, "I learned ___" were in line with the content shared in the activities and included specific topics, such as, "how robots work in space" or "that the Sun has magnetic fields". Other responses were too general to really be considered in line with the content, and these included responses like "some stuff" and "a lot". When their comments were coded for the four SMD content areas, most children's responses were related to astrophysics (40%) or planetary science (38%) (see Table 15 for examples of their responses and how they were coded), mirroring the trend we saw above in adult responses where examples from these two topics surfaced the most while Earth science and heliophysics examples were shared less often.

Table 15. Children's open-ended responses about their learning coded by SMD content areas. (n=124)

Content Learned	Response Examples*
Astrophysics (40%)	*"Gravity, Earth, and magnetic things."* *"Some things you can see with different stuff."* *"That the sun has magnetic fields."** *"That planets have a gravitational pull with their moons."**
Planetary science (38%)	*"Crater shapes can look very unique."** *"That the moon has icy cycles and not because it has water. It's because it has no atmosphere."* *"That the mass of a planet can change the size of the rotation."* *"There are little bits of water on the moon."*
Earth science (20%)	*"A lot about Earth."* *"About the mountains when it rains."* *"Mountains break."*
Heliophysics (12%)	*"That the sun has sun spots."* *"That we are really close to the sun."* *"The sun has magnetic fields."**

*Responses that are coded into more than one category are indicated by an asterisk.

Visitors were significantly more confident talking about SMD content. In order to specifically address how understanding of the SMD content areas may have changed, we created four action statements for adults to reflect upon. Each action statement was an applied way of talking or sharing about one of the four SMD content areas, using examples that were drawn from the topics that families were likely to learn about when interacting with the activities. In the post survey, adults were asked to rate their confidence talking about each of these ideas before and after trying the activities. Each of these statements also links back to the content map (see Appendix B) and a fifth action statement was added to the instrument so that all aspects of the content map would be addressed in the evaluation.

These action statements are listed here, with the SMD content area they are linked to in brackets:

- Tell a friend at least one way that planet Earth is constantly changing. [Earth science]
- Describe at least one way that the Sun interacts with the Earth and the solar system. [heliophysics]
- Share at least one way that scientists are studying other planets. [planetary science]
- Describe how tools reveal energy and forces at work in the universe. [astrophysics]

- Share at least one way that people are choosing to explore Earth and space. [content map only]

Adults were significantly more confident sharing, telling, or describing aspects of Earth and space in each of the four SMD content areas (Earth science, heliophysics, planetary science, and astrophysics) after trying the activities (see Table 16). This was also true for confidence around “sharing at least one way that people choose to explore Earth and space”. The effect size was calculated using the PS_{dep} statistic and shows that the activities had the most impact on visitors’ confidence sharing about how scientists study other planets (PS_{dep} = 0.46). This means that 46% of the time, we would expect visitors to have a positive change in confidence after trying these activities, instead of remaining the same or losing confidence. For more about understanding the PS_{dep} effect size and the detailed changes in ratings around the five action statements, please see Appendix G.

Table 16. Adults’ levels of confidence before and after trying Explore Science: Earth & Space activities.

	Percent of visitors reporting top two levels of confidence after activities	Mean confidence score, pre	Mean confidence score, post	Effect size*
Share at least one way that scientists are studying other planets. (n=208)	75%	2.51	2.97**	0.46
Describe how tools reveal energy and forces at work in the universe. (n=205)	69%	2.40	2.85**	0.41
Describe at least one way that the Sun interacts with the Earth and the solar system. (n=205)	77%	2.73	3.03**	0.31
Share at least one way that people are choosing to explore Earth and space. (n=201)	76%	2.72	3.04**	0.31
Tell a friend at least one way that planet Earth is constantly changing. (n=207)	79%	2.79	3.05**	0.30

*Effect size calculated for nonparametric Wilcoxon signed ranks test using “PS_{dep}”, in which $PS_{dep} = n_+/N$. More on this in supplemental findings section (see Appendix G).
**Mean increases are significant at $p<0.0005$, Wilcoxon signed rank test; scale goes from 1-4.

In order to understand how well visitors' confidence ratings corresponded with being able to share, describe, or tell a friend about the content, we asked visitors who provided "confident" or "extremely confident" ratings after trying the activities to tell us more about them. We probed with the question, "How might you share or describe this to someone?" after a visitor picked one of the statements they felt comfortable talking about. One of the limitations of this study is that we were unable to collect many interviews, and only eight visitors responded to the prompt, so these data are inconclusive. The complete set of responses is provided here and is coded by the statement they were explaining (see Table 17).

Table 17. Adults share why they gave confident ratings for these statements.

Statements	Interview responses
Share at least one way that scientists are studying other planets.	*"Crater experience. I sat there, it was very cool and learned so much."*
Describe how tools reveal energy and forces at work in the universe.	*"When you go to space, you have different magnetic tools to use. There are things available to use."* *"Seeing telescopes, using binoculars, or imitating the rover."*
Describe at least one way that the Sun interacts with the Earth and the solar system.	*"I knew a lot of this stuff before. I think it's neat; the Earth and sun and magnetic things. It was neat to watch the first crater and to see how magnets worked to pick up. And then going to see Earth and poles. You can imagine Earth is like a magnet and keeps spinning with the sun."* *"I knew already the physics and the principle examples; how you use the telescope and the filter. "* *"After I saw the rocket, I thought, 'Yeah—I can build this!'"*
Share at least one way that people are choosing to explore Earth and space.	*"Seeing how they are exploring other planets with telescopes."* *"Filtered light with James Webb, learned more about how astronomers are looking at galaxies, and red and blue light separately."* *"The galaxies with the different colors."* *"We built robots, created tools to leave the planet, and had remote telescopes, The rover. "* *"More or less, the difference between what happens in space and on Earth. Like craters and how weather on Earth can affect them."*
Tell a friend at least one way that planet Earth is constantly changing.	*"Seeing pollution from the top of the mountain."*

Finding 5: Earth and space topics were more relevant for families after trying the activities.

Earth and space topics felt more relevant for families. Most adults (72%, n=237) felt that Earth and space topics were "more relevant" to their group's "life and experiences" after trying the activities, while about a quarter (27%) indicated that there was "no change" and 1% marked that the topics were "less relevant" (see Table 18).

Table 18. Adults' reflections on changes in relevance of Earth and space activities for their group after trying the activities. (n=237)

Change in relevance	% of adult respondents
More relevant	72%
No change	27%
Less relevant	1%

Children were able to draw connections to their daily lives. One way of understanding how relevant an experience is to a person is to ask how it connects to experiences that they've already had. We asked children to fill in the blank for "These activities reminded me of ____" and coded their responses to see what kinds of connections children were or were not making between the activities and their previous everyday life experiences. These responses were comprised of related content (33% shared something to do with space), locations (20% shared how these reminded them of something at school), and personal connections (11% shared aspirations, more about people they knew, or about something else meaningful to them) (see Table 19). Other ideas mentioned were general science experiences (like doing an experiment), going on a museum trip, or Earth. Almost a third of comments (26%) did not fall under other codes and were grouped together. Seven children shared that the activities did not remind them of anything.

Table 19. Children's connections to the activities. (n=120)

Themes	Response Examples*	% of Responses
Space	*"The moon and gravity."* *"Learning about space."* *"Outer space."* *"Space engineers."*	33%
School	*"When I went to science and at school."* *"What I learn at school."* *"School and what an architect would do."* *"Science class but funnier."*	20%
Personal connections	*"What I want to be when I grow up. My parents also encourage me with whatever I want to be."* *"My friend's mom, because she studies space."* *"The sand reminds me of the sandbox at our old house."* *"My room."* *"Rover reminds me of Simon says."* *"A book I read."*	11%
General science	*"Science experiments."* *"A lab."* *"Computer programming."*	8%
Museum trips	*"When I went to the Museum of Science."* *"Going on my field trip and adventuring."* *"Going to the science museum."*	7%
Earth	"Earth!"	1%
Other	*"Just having fun learning."*	26%
Nothing	*"Nothing I did before."* *"Nothing."*	6%

*Some responses were coded under more than one theme.

Interviews were conducted with some family groups to gain deeper understanding of how families were connecting their experiences with the activities to their everyday lives. We prompted adults by saying, "I noticed that you indicated your group felt that these topics were more relevant, after trying the activities. Could you tell me a little more about that?". Some of the adult responses included things like, "…getting a sense of the bigger picture", …understanding things more.", "…just more interested, so more relevant to me, "while one child responded that they wanted to do more craters. Below is a complete list of responses from the groups we interviewed.

Groups' responses about why Earth and space topics felt more relevant after trying the activities (n=11)

- She's still talking about it! She's really trying to get to the craters after this.
- I don't know. Sensed [that] kids got a sense of the bigger picture.
- Children to learn that Earth protects them. Ability to learn how magnetic fields surround us. The crater activity, made us think about Crater Lake.
- Having an activity or museum that allows kids to do things, hands-on, meaningful to us.

- Because now it's in their head now. They'll see things and understand things more. [Child responds, "Yes, I want to do craters."]
- He's really interested in space/telescopes. Gives him a goal for his future. Inspires kids to look to science. Things/how they can be involved in the future.
- Now I more stuff – don't feel like lost when show me something." Nice to have new stuff for vacation.
- With my kids and staff. The fact that we'll probably talk about it more. When kids get more interested in something, they like go to the library more. Probably talk to their aunt more as she worked for NASA out of college for 3 years.
- I don't know, just more interested so more relevant to me because I liked it. Tells you more about what is happening.
- I don't know.
- I don't know, it just did.

Finding 6: Families reported being able to look closely, use their imaginations, choose and explore ideas in hands-on ways, work together, and share discoveries at the activities.

Families reported engaging in behaviors that the project team considered useful for exploring or supporting a science identity. We asked children to report how often they felt they were able to look at something closely, play and use their imagination, choose ideas to explore, do something hands on, work together, or share a discovery at the activities. Then, we asked adults how often their groups were able to do each of these things. Most children (73%, n=143) and adults reporting for their groups (89%, n=239) indicated they were able to "do something hands on to learn more" "a lot" at the activities they tried (see Table 20). Working together was reported happening "a lot" by the fewest number of adults (60%) and children (50%).

Table 20. How often adults and children reported being able to do each of these behaviors "a lot".

Behaviors	% Children (n=143)	% Adults (n=239)
Do something hands-on	**73%**	**89%**
Look at something closely	61%	81%
Play and use imagination	60%	71%
Share a discovery	53%	72%
Choose ideas to explore	52%	64%
Work together	50%	60%

We also observed how often groups were engaging in these behaviors (see Appendix F for how we defined each behavior), by marking down when children or adults in a group did an action at the activities. While our data is broken down by activity, it is not divided by individual adults and children; rather, if multiple children were in a group, we marked a behavior if *any* of the children did it. The same was true for cases where there were multiple adults in a group. In Table 21, we counted a behavior as happening if any child or any adult did that behavior during any of the activities that they tried. Since adults and children were reflecting on their experiences with the activities as a whole, it felt most appropriate to group the data in this way.

Almost all groups that we observed (95%, n = 44 groups) had children doing something hands-on (see Table 21). In many cases (77%), it also seemed like they were working together (our observations coded working together as any situation in which a person was talking to another about what they were doing or adding on to another's materials) or choosing ideas to explore (77%). Adults in the group were most likely to work together by our broad definition (70%) and much less likely to engage in imaginative play (20%) while trying the activities.

Table 21. How often adults and children were observed engaging in these behaviors at the activities (n=44 groups).

Behaviors	Children observed in % of groups	Adults observed in % of groups
Do something hands-on	**95%**	50%
Work together	77%	**70%**
Choose ideas to explore	77%	41%
Look at something closely	75%	52%
Play and use imagination	57%	20%
Share a discovery	55%	41%

Finally, fourteen adults responded to interview questions where we asked respondents who had marked at least one item "a lot" to share more about that. We prompted them to consider when they were able to do these things and at which activities. Visitors talked about the Craters activity, the Paper Mountain activity, and the Hide & Seek Moon activity as being especially likely to make them look closely "a lot". Some people shared that the Mars Rovers activity was good at providing hands-on opportunities to learn more and work together, as well as let them choose their own ideas to explore. The Filtered Light activity helped one family share their discoveries (see Appendix A for a list of all toolkit activities included in the evaluation).

Adults' reflections on when they were able to engage in specific behaviors at the activities "a lot" (n=14*)

*Note: Some participants gave more than one response.

Do something hands-on to learn more

- All the activities were hands on, something to pick up or build, not just standing and reading, using the tools.
- Seeing the different impacts marbles and pebbles had. Heavier had a bigger impact. Interesting to see these effects.
- Interact with information. I can work with my hands.
- Hands-on learning is really important. If you work with it, you learn more about it.
- Weight of the clay thing. Helping her do it.
- Hands-on experience for the magnetic fields.
- Space telescope.
- Interact with information; I can work with my hands.

Look at something closely

- When child was at sand craters. I found it really interesting, the different sizes, on top of another, and only Earth has a weather effect on the impressions made.
- Paper mountain, looking at that really closely to see what happened.

- Looking at moon and discovering animals. Kind of shocked me seeing the cat and others.
- Was able to get close to the table and work and see/participate in the demo.
- Magnetic fields.
- At Filtered light, he could write his name and see the colors disappear. We had to look closely.
- Hide and seek moon, put over binoculars, you could see things you couldn't see before.

Play and use your imagination

- Watching others versus the way we did it. Everyone had different terminology.
- You have to use your imagination to find out how to fold it. You have to think a lot.
- Playing and dropping rocks/marbles. Didn't realize there was many magnetic fields on the sun.
- Space telescopes.

Choose ideas to explore

- The rover because you had to have faith in the person explaining to you where to go.
- Space telescope.

Work together with my group

- The Rover: to see my kids work together always a good thing.
- Weight of the clay thing. Helping her do it.
- Working together – Rockets – it was cool. "Let's do mine!" "Let's do another round!"
- The clay project the most.
- Space telescope.

Share a discovery

- A discovery that [my child] shared was the red and the blue missing colors. I felt privileged that he wanted to share that with me.

Finally, we asked adults and children if engaging in the activities made them feel more like someone who can learn about or do science, and if so, how. Seven children responded in positive ways, with some sharing examples of things they had learned about scientists (see responses below). Most adults talked about the hands-on nature of the activities as feeling especially important. Other adults shared that the relatability of the activities for children supported their experiences and a couple shared that the activities felt approachable for everyone and easy to understand.

Children's responses about how the experiences may have made them feel like a person who can learn about or do science. (n=7)*

- Yes. It helped me do science, because I know scientists look up at the moon and discover it and the craters, and I think they do rockets, too, some of them. I know they discover what's new in the world. I saw this on YouTube videos with scientists and chemicals.
- Yeah. I have a lot of science classes at school and I want to continue, since I have a lot of experience.
- Yeah, because I was interested in space when I was little.
- They helped me understand a bit better what scientists do. I can do science. Other scientists go to the moon and bring rocks from the moon.
- Yes, try to do stuff and make stuff.
- A little bit, but not sure why.
- Yeah, because learning about space is learning about science.

Adults' responses about how the experiences may have made them feel like a person who can learn about or do science. (n=12)

- Yeah, anything we can explore makes us feel confident we can explore science. Hands on stuff is our style.
- Yes, you always learn better when doing something with your hands and practicing. Deeply involved.
- Yes! It's hands on activities. It's how I learn. But for kids it's a great way to learn, even though they may not remember all – the sensory leaves a big impact.
- Yes, he loves science. He's older and needs stuff that's hands on and gets to interact with.
- Yeah. Because any little day-to-day things can [be messed with] and can make something cool of it. [Like] the tubes from the rockets.
- Sure, having a model to look at and touch.
- Yes, it's the ability for [the kids] to touch, feel, and see materials.
- Yes. Probably made me think more about what we do with kids at home. Gave me some suggestions.
- Yes. I feel like opening kids and especially daughters to science is really important. The fact that those experiences apply to all ages; everybody at the table is learning something.
- Not too technical. They put it in words you can understand.
- Brought it down to earth. Very engaging colors. Put the info in a way we could understand.
- It was like an experiment he did. It is what scientists do.

Areas for Attention

During our data collection and analysis, we noticed a few things that the project team may want to keep in mind during future toolkit development. Some sites we collected at had less than a 1:1 ratio of facilitators to activities, and in a couple cases, only one facilitator was overseeing several activities. Future kit developers could consider providing some activities and supporting materials that can more readily stand on their own without facilitation, if needed. Another thing for the team to consider may be new ways to engage families so that they feel like they are working together more during the activities. While our observations reflected that people within groups were talking with others while completing the activity, this was the lowest reported action by both adults on behalf of their groups and children, and may be an opportunity to strengthen the impacts of future toolkits. Finally, it should be noted that when we asked children what the activities reminded them of, they most often shared about related content. While connections to other content may be important, people often share that informal environments are prized for forming emotional or personal connections to topics. Future kits might focus on supporting families to make these personal connections to their experiences at the activities more readily.

Conclusion

Overall, the *Explore Science: Earth & Space* activity toolkits met the project team's goals. Almost all adults felt the activities were engaging and interesting for their groups, and most children found the activities to be fun. Most adults shared that they felt their groups learned something and their open-ended comments, while not highly specific, suggested that they were having experiences in line with the content that developers hoped they would walk away thinking about. Adults also reported significant increases in their confidence being able to share ideas related to the four SMD content areas after trying the activities. Most children and adults expressed that they felt more curious or interested about Earth and space topics after trying the activities, and most adults also felt these topics were more relevant to their everyday lives. Most of the child responses to the question about what they thought the activity topics reminded them of included responses related to activity content, as well as responses that included both related content and their everyday life connections to that content. Finally, most adults and children reported being able to engage in the activities either “a little” or “a lot” in ways that the project team felt aligned with the support or exploration of a positive science identity.

References

Association of Science-Technology Centers. 2017. *Science Center Statistics 2017*. Washington, DC.

Grissom, R. and Kim, J. 2012. *Effect sizes for research: Univariate and multivariate applications.* New York, NY: Routledge, Taylor & Francis Group.

National Research Council. 2009. *Learning Science in Informal Environments: People, Places, and Pursuits*. Washington, DC: The National Academies Press. https://doi.org/10.17226/12190.

Ostman, R. 2016. Internal presentation at October 5, 2016 in-person meeting about the goals and progress of the first activity toolkit’s completion.

Appendix A: *Explore Science: Earth & Space* Activity Toolkits

The SEISE project charged itself with developing 250 copies of an activity toolkit to be distributed each year in 2017-2020, which was later modified to 350 copies in 2019 and 2020. During the first two years, 250 copies of each toolkit were sent to successful applicants from children's museums, science centers, and observatories in rural and urban settings across the United States. Toolkit recipients agreed to integrate the activities into at least one event for the public in the first five months of receiving it.

Description of Toolkits

Two toolkits were created, one in 2017 and one in 2018. The 2017 toolkit had nine activities and the 2018 kit had 10 (see Table 22). These activities allowed visitors to explore Earth and space science through topics in heliophysics (H), Earth science (ES), planetary science (PS), and astrophysics (A); each of the activities in the table below is followed in brackets by the SMD content areas they address. The nine activities in the 2017 toolkit heavily focused on heliophysics and Earth science, and featured four the activities as a mini-kit for the August 2017 solar eclipse. The 2018 toolkit showcased planetary science and astrophysics more deeply. The heliophysics theme tied in with the August 2017 solar eclipse, with many of the activities providing context or interpretation of that phenomena.

Table 22. Activities Included in the 2017 & 2018 Activity Toolkits.

2017 Toolkit Activities	2018 Toolkit Activities
Investigating Clouds [ES]	**Hide and Seek Moon [ES]**
Rising Sea [ES]	**Paper Mountains [ES]**
Bear's Shadow [H, ES]	**Craters [ES, PS]**
Solar Eclipse [H, ES]	**Magnetic Fields [ES, PS, H]**
Big Sun, Small Moon [H, ES]	**Stomp Rockets [ES, H]**
Imagining Life [PS]	**Exoplanet Transits [PS]**
Pocket Solar System [PS]	**Mars Rovers [PS]**
Ice Orbs [PS]	**Objects in Motion [PS, A]**
Orbiting Objects [PS, A]	**Pack a Space Telescope [A]**
	Filtered Light [A]

Toolkits included all of the materials necessary to run an activity (with the exception of water, ice, or other resources easily obtained by the facilitator). For example, the Solar Eclipse activity (see Figure 3) came with models of the Earth and moon, a pump to inflate the Earth beach ball, a cone for the Earth ball to rest on, a flashlight, the information sheets, and activity and facilitator guides. The facilitator guide outlined the learning objectives, listed the necessary materials, provided tips for the facilitator specific to that activity, along with some misconceptions that visitors might have, and where to find additional training resources. Online content training videos were also developed, shared and recommended for activities.

Figure 3. Two children engage in the Solar Eclipse activity.

Figure 4. Paper Mountains activity from 2018 Toolkit.

Another example of a toolkit activity is Paper Mountains (see Figure 4), which demonstrates how scientists study Earth from above. The activity contains paper, washable markers, bottles, a towel, a try at home hand out, activity and facilitator guides, and information sheets with extra information. Water needs to be used for this activity as well. The facilitator guide discusses learning objectives and supplies. It gives notes to the facilitator, including how this activity could work for visitors with low or no vision. It can be easily adapted to be mainly tactile. The guide continues on giving instructors and facilitators prompts, information about the takeaway card for home use, ways to approach difficult concepts, and links to training videos and other resources. Visitors use this activity to create a mountain environment, trace a line along a peak, and explore a watershed system in a hands-on way.

In addition to the activities, toolkits contained facilitator guide, participant guides, information sheets, as well as eclipse-related materials (2017 only), promotional banners, press releases, sign stands, table clothes, and temporary tattoos.

Learning framework

1. Experience Earth and space PHENOMENA and explore scientific discoveries

a. Experiencing the joy of active learning, including play, discovery, invention, and experimentation

i. Learning is a continuum, which connects and builds on past and future experiences.
ii. Learners can work alone or in groups to discover new knowledge and build skills.
iii. Both novices and experts can be excited by seeing or understanding something for the first time.
iv. Learners can recognize and overcome common misconceptions about our planet Earth and the solar system.

b. Experiencing real phenomena, celestial events, and compelling imagery

i. We can directly observe and experience many phenomena related to Earth and space science.
ii. The study of celestial events can spur curiosity and contribute to our personal and collective knowledge.
iii. The universe can be very beautiful.

c. Exploring and understanding our place in the universe

i. The universe is very large and can be difficult to conceptualize.
ii. The universe is always changing: galaxies are colliding, stars are forming and dying, and the Earth and solar system are hurtling through space.
iii. Space has many dangerous environments that can be harmful to both humans and robotic instruments.

d. Investigating the big questions that drive Earth and space research

i. How did life on Earth start, and are we alone in the universe?
ii. How did the universe begin, and how were our galaxy, solar system, and planet formed?
iii. What protects life on Earth and how do humans change these conditions?

2. Use the scientific PROCESS and reflect on science as a way of knowing

a. Engineering and scientific research is an iterative design process

i. Planning and executing a NASA mission is a long process with many steps.
ii. Missions do not always go as planned and sometimes have unanticipated results, but all missions provide valuable information that provide data and inform future missions.
iii. Grand challenges in Earth and space research are often broken down into simpler problems to be tackled one at a time.

iv. While quantitative methods and critical thinking are important in solving problems, ingenuity and imagination are also helpful in advancing us to the next stage of knowing.

b. Using a variety of tools and approaches to make discoveries

i. NASA science teams collect important data using satellites and other instruments to look out into space as well as back at Earth.
ii. We need many different kinds of information and perspectives to answer the big questions that drive space and Earth science research, which means we need both diverse teams and tools.
iii. People use scientific tools, such as robot explorers and remote-controlled instruments, as extensions of their senses to observe and collect data about Earth and space.

c. Understanding the power and limitations of data sets

i. Data about Earth and space can be analyzed in different ways to support multiple theories.
ii. Data are interpreted and weighed as evidence against theories in Earth and space science. Whether or not data support previous ideas, they increase our understanding of big scientific questions and led to new ideas to investigate.
iii. Data can also be misinterpreted and presented incorrectly. When we hear stories and see images about Earth and space, it can sometimes be difficult to judge their accuracy.

d. Making and using models to communicate and further our understanding

i. We need models to show invisible forces present in fields: electrical, gravity, and magnetic.
ii. Models can be changed over time as we gain new data and our understanding improves: they may be refined, improved or rejected. Examples include changing models of the solar system over time and the debate over the ninth planet in our Solar System.

e. Using our imagination and ingenuity to explore the universe

i. Imagination, play, and practical ingenuity can all lead to creative solutions for big challenges in space and Earth science exploration.
ii. Play can lead to innovative new methods and tools to explore Earth and space.
iii. Narrative, science fiction, and visions of the future can inspire us to ask new questions and motivate us to take on grand challenges.
iv. Dreaming about space and exploring new frontiers have motivated many scientists to become who they are today.

3. PARTICIPATE in the scientific community and identify as a science learner

a. Working together in groups to accomplish goals and tackle challenges

i. NASA missions involve many different types of people and communities working together over a long period of time.
ii. Mission teams must cooperate, communicate, and take advantage of their diversity of experience, expertise, and perspectives.

iii. Missions require many different tools, instruments, and methods--all designed to work together.
iv. Major discoveries in Earth and space science can take years and years of work by many different people, including scientists and citizens.

b. Recognizing the relevance of Earth and space science

i. There are many connections between Earth and space science to our everyday lives.
ii. We can build on existing knowledge and find future opportunities to learn about Earth and space science.
iii. Diverse cultures and communities have their own ways of observing nature and passing down knowledge about Earth and space, which influence the perceived relevance of Earth and space science.

c. Considering the social dimensions of Earth and space science

i. As individuals and as a society, we make decisions about what kinds of science to pursue and fund.
ii. Some scientific questions can be pursued by individuals with relatively little resources. Other questions require commitment of many people and resources.
iii. Our individual and cultural values influence the science and technologies we develop, and the ways we use them.

d. Identifying as someone who learns about and sometimes participates in current research

i. There are many opportunities to learn about Earth and space science, at home, in school, and in the community.
ii. We can all participate in Earth and space science as citizen scientists, by recording data from our home planet.
iii. Citizen scientists are contributing data to ongoing space and Earth science research projects.

Appendix C. Content Map for *Explore Science: Earth & Space* Toolkits

The Sun powers Earth and our solar system.

The Sun radiates a massive amount of energy across the entire electromagnetic spectrum and through a shifting stream of charged particles.

- Energy and particles from the Sun
- The Sun and life on Earth
- The Sun and the solar system

Planetary systems like ours may contain water and life.

The solar system contains many planets, moons, and smaller objects; some may have water or support life similar to objects in other planetary systems.

- Solar system beginnings
- Solar system objects
- Water and life in the solar system
- Exoplanets

Earth is a changing planet of air, water, rock, and life.

Earth is dynamic system with a changing climate due to interactions between air, water, rock, and solar input, in addition to human activities.

- Earth is a water planet
- Earth is a rocky planet
- Diverse lifeforms of Earth
- Human influence on Earth

The universe is very large, old, and mysterious.

In 14 billion years, the universe has gone from a small, hot ball a few millimeters across to a huge expanse of galaxies, stars, and planetary systems almost 50 billion light years across, and still expanding today.

- The big bang and other models
- Life cycles of stars
- Light from the universe

Our society chooses to explore Earth and space.

- Our values influence questions
- Inspiration for new technology
- Better decisions about our home
- Teamwork and specialized tools

Forces and energy connect everything in the universe.

- Electromagnetic spectrum
- Gravity
- Magnetism

v2/23/18

Appendix D: Site Vignettes

We have included two vignettes about sites where we collected data in order to give the reader a better sense of what some of the *Explore Science: Earth & Space* activity programming was like during the evaluation. The following sites were specifically chosen for this report as first-hand experience examples where the authors of this report conducted the data collection. A more detailed description of the sites, including data collected through the Event Description Form can be found in the "Event Description Data" section on page xx).

The Bakken Museum, Minneapolis, MN

The Bakken Museum is located in the historic West Winds mansion and includes a historic collection of scientific and medical instruments, content focus on the history of electricity and magnetism, as well as everything there is to know about Frankenstein. This unique blend of exhibits and content offered family groups a relevant and appropriate environment to engage with and learn about the Earth & Space toolkit activities (esp. Magnetic Fields, Objects in Motion, and Filtered Light).

A total of eight activities were situated across two main rooms at the Bakken Museum in Minneapolis, MN, on Friday March 30, 2018 from 12 to 4pm and Saturday March 31, 2018 from 11am to 4pm. A total of seven activities (Objects in Motion, Hide and Seek Moon, Filtered Light, Craters, Exoplanet Transits, Pack a Space Telescope, and Magnetic Fields*)* were in one central hall, while the *Mars Rovers* activity was situated in a separate adjacent room, in order to accommodate the physical space required to lay out the activity.

One experienced staff facilitator was available on each day of data collection and were generally available for each activity as family groups "activity-hopped" from one activity to the next. This facilitator encouraged and guided visitors through each steps of the activities and made sure materials and overall set up were ready for the next group of participating visitors. Across both days of data collection, overall visitor attendance through the museum and the area where the activities were situated was moderate and fluctuated between low traffic and a sudden increase of visitors. Though the latter was ideal for data collection, there were times where the influx of visitors walking through the central area where data collectors were situated caused minor difficulties for maintaining a good sense of which groups were being approached by different data collection staff. In total, data collection was relatively low but as this was the first official data collection site, the evaluation team was able to reflect, discuss and make changes to both protocol and instruments.

First Free Friday and Star Wars Day at the Washington Pavilion, Sioux Falls, SD

The Washington Pavilion is a recently renovated mid-sized science and technology museum that also houses a Visual Arts Center and regularly hosts regional and national acts at the Husby Performing Arts Center. The museum is located in downtown Sioux Falls, South Dakota and greets a yearly visitorship of 68,000 people.

Data collection at the Washington Pavilion took place on Friday May 4th, 2018 (aka "May the Fourth be With You", in reference to national "Star Wars Day") from 5 to 8pm and Saturday May 5th, 2018 from 10am to 2pm. During the first day of data collection, the museum hosted its first "Free Friday" and the film opening of "In Saturn's Rings." On the second day, the museum celebrated Star Wars Day and invited the 501st Legion, a Star Wars universe fan-based group that typically attends other sci-fi related events around the nation and throughout the year, in full character costumes.

On Friday May 4th, four activity tables were set up in a maker space (Jack's Imagination Lab) that was previously used as a museum gift shop, approximately 400 square ft. The "Kirby Science Discovery Center" which houses a large group of space exhibits, was situated right next to the maker space, making it convenient and readily accessible to relevant exhibit hall content. Since the maker space area was relatively new and not clear as to what it was (limited/no clear signage), visitors tended to go into the exhibit gallery (i.e., Kirby Science Discovery Center) adjacent to it instead of the maker activity area.

During the second day of data collection, Star Wars day kicked-off early and the crowds seemed excited about having their pictures taken with Star Wars characters roaming throughout the museum and the exhibit gallery right next to the maker space where the E&S activities were. On this day, the data collection team suggested to museum staff to include signage and place one of the activities (*Stomp Rockets*) at the entrance of the Maker Space. The latter served to increase visibility of and excitement for the Earth & Space activities as visitors passed through the exhibit gallery hall way.

At this site, *Objects in Motion*, *Filtered Light, Stomp Rockets, and Magnetic Fields* were featured. These activities were facilitated by a museum staff informal educator and a high school student volunteer. The staff educator was actively engaging visitors with activities. This educator was relatively more experienced (3+ years) than the student volunteer. For the latter, it was their second time facilitating activities.

Figure 5. Adult Survey.

EXPLORE SCIENCE Earth & Space

Adult Survey

Thank you for participating in our study. Your responses will help us understand how these activities are working for both adults and kids. Responding is voluntary, and you and your group can stop at any time. Thank you!

Think about the Earth & Space activities your group just tried.

1. How enjoyable were the activities for your group?

☐ Not enjoyable ☐ A little enjoyable ☐ Enjoyable ☐ Very enjoyable

2. How interesting were the activities for your group?

☐ Not interesting ☐ A little interesting ☐ Interesting ☐ Very interesting

3. At the activities, how much did your group get to do each of the following?

	Not at all	A little	A lot
Look at something closely.	☐	☐	☐
Play and use your imagination.	☐	☐	☐
Choose ideas to explore.	☐	☐	☐
Do something hands-on to learn more.	☐	☐	☐
Work together.	☐	☐	☐
Share a discovery.	☐	☐	☐

4. After trying the activities, how interested is your group in Earth & Space topics?

☐ LESS interested ☐ No change ☐ MORE interested

5. After trying the activities, how relevant do you feel these Earth & Space topics are to your group's life and experiences?

☐ LESS relevant ☐ No change ☐ MORE relevant

6. Did your group learn anything new at the Earth & Space activities today?

☐ Yes ☐ No ☐ Unsure

6b. If yes, what are 1 to 2 things that you learned at the activities?

6c. What are 1 to 2 things that you think the children in your group may have learned at the activities?

NEXT

7. BEFORE trying these Earth & Space activities, how would you rate your confidence in your ability to do each of these? (Please circle ONLY ONE choice per row.)

Opportunity	Level of Confidence			
Share at least one way that scientists are studying other planets.	Not at all confident	Somewhat confident	Confident	Extremely confident
Describe at least one way that the Sun interacts with the Earth and the solar system.	Not at all confident	Somewhat confident	Confident	Extremely confident
Tell a friend at least one way that planet Earth is constantly changing.	Not at all confident	Somewhat confident	Confident	Extremely confident
Describe how tools reveal energy and forces at work in the universe.	Not at all confident	Somewhat confident	Confident	Extremely confident
Share at least one way that people are choosing to explore Earth & Space.	Not at all confident	Somewhat confident	Confident	Extremely confident

8. Now AFTER trying these Earth & Space activities, how would you rate your confidence in your ability to do each of these? (Please circle ONLY ONE choice per row.)

Opportunity	Level of Confidence			
Share at least one way that scientists are studying other planets.	Not at all confident	Somewhat confident	Confident	Extremely confident
Describe at least one way that the Sun interacts with the Earth and the solar system.	Not at all confident	Somewhat confident	Confident	Extremely confident
Tell a friend at least one way that planet Earth is constantly changing.	Not at all confident	Somewhat confident	Confident	Extremely confident
Describe how tools reveal energy and forces at work in the universe.	Not at all confident	Somewhat confident	Confident	Extremely confident
Share at least one way that people are choosing to explore Earth & Space.	Not at all confident	Somewhat confident	Confident	Extremely confident

9. Your age:__________ **10. Ages of the people in your group today:___________**

11. What is your gender?

☐ Male ☐ Female ☐ Prefer not to say ☐ Another Category: Please specify _____________

12. With which racial or ethnic group(s) do you identify? (Check all that apply.)

☐ American Indian or Alaskan Native ☐ Asian ☐ Black or African American ☐ Hispanic or Latino

☐ Native Hawaiian or Pacific Islander ☐ White ☐ Other:______ ☐ Prefer not to say

13. About how many Earth & Space activities did your group try today? ____________

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Figure 6. Child Survey.

EXPLORE SCIENCE
Earth & Space

Kid Survey

We want to know what it was like to do the activities today.

You can fill out as much or as little as you want. Thank you!

Tell the adult that you're with the number in this star!

They should write your number on the very end of their survey.

Think about the Earth & Space activities you just tried.

1) How fun were the activities?

○ Not fun ○ A little fun ○ Really fun

2.) How curious are you about Earth & Space after trying the activities?

○ Less curious ○ About the same ○ More curious

3.) At the activities, how much did you get to do each of the following?

	Not at all	A little	A lot
Look at something closely.	☐	☐	☐
Play and use your imagination.	☐	☐	☐
Choose ideas to explore.	☐	☐	☐
Do something hands-on to learn more.	☐	☐	☐
Work together with my group.	☐	☐	☐
Share a discovery.	☐	☐	☐

Now, fill in the blank.

4.) I learned ____

____.

5.) These activities reminded me of ____

____.

6.) I am __________ years old.

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Figure X. Group Interview

EXPLORE SCIENCE Earth & Space

Family Interview

Name of interviewer: ________________ **Date:** _______

Adult responses	Under 18 responses
1) Thinking about the Earth & Space activities that you just tried, what was your favorite activity? Why?	
2) On your surveys, someone in your group indicated that you got to do the following 'a lot' (☐ Look closely, ☐ Play, ☐ Choose ideas, ☐ Hands-on, ☐ Work together, ☐ Share discovery). **Could you pick one to tell me a little more about when you got to do that in the activities? (Possible prompt: What did that look like?)**	
3) Did these experiences make you feel like you are a person who can learn about and/or do science? How so?	

Adult responses	Under 18 responses
4) I see that after trying the activities, you noted that you felt confident doing these things (indicate items on the adult's survey). **Could you pick two to tell me a little more about?** (How you might share or describe this to someone?)	
Item: _____	
Item: ______	

2

Adult responses	Under 18 responses
5) [If true] I see that after trying the activities, you indicated that your group was more interested in the Earth & Space topics that the activities covered. **Could you tell me a little more about that?**	
6) [If true] I also noticed that you indicated your group felt that these topics were more relevant, after trying the activities. Could you tell me a little more about that?	

3

Figure 7. Group Observation

Family Uncued Observation Observer Initials: ________ Date:__________ Unmatched Observation Number:________
OR Family Case Number:________

		Adults		Children	
Activity #:___	**Looked at something closely**	Y / N	H / L	Y / N	H / L
	Seemed to play/use imagination	Y / N	H / L	Y / N	H / L
	Explored an idea	Y / N	H / L	Y / N	H / L
	Did a hands-on action	Y / N	H / L	Y / N	H / L
	Worked with someone else	Y / N	H / L	Y / N	H / L
	Shared a discovery	Y / N	H / L	Y / N	H / L
Activity #:___	**Looked at something closely**	Y / N	H / L	Y / N	H / L
	Seemed to play/use imagination	Y / N	H / L	Y / N	H / L
	Explored an idea	Y / N	H / L	Y / N	H / L
	Did a hands-on action	Y / N	H / L	Y / N	H / L
	Worked with someone else	Y / N	H / L	Y / N	H / L
	Shared a discovery	Y / N	H / L	Y / N	H / L

Figure 8. Event Description Form

EXPLORE SCIENCE Earth & Space

Event Description Form

Event date:___________________ **Institution:**____

Before event

1. **What time does the event start today?**___________ **What time does it end?** ________________
2. **What time are you starting data collection?** _________ **Ending data collection?** ___________
3. **Including the Earth & Space activities arrangement, describe the layout of the event.** (Is it all one floor or on several floors? Is it concentrated in a hallway or in a special activity room? If this is a themed event, can you describe it?)
4. **How prevalent are other exhibits or activities with Space & Earth content?** (Please describe if these are galleries, single exhibits, stage shows, demonstrations, tabletop activities, etc…)
5. **Please share anything you observe or understand about the facilitators, regarding their experience with the specific activities, the content, or leading table top activities.** (For example, are these relatively inexperienced high school volunteers? Informal education staff? Amateur or professional astronomers? Have they facilitated these or other activities before today?)
6. **Please check each of the Earth & Space activities that are on the floor today. Note that activities might be from one or both years at your institution. In your set of Toolkit Activity Flashcards, remove all cards for activities that are not on the floor and set these aside.**

2017 Toolkit Activities		2018 Toolkit Activities.	
☐ 1. **Big Sun, Small Moon**	☐ 6. **Imagining Life**	☐ 10. **Objects in Motion**	☐ 15. **Paper Mountains**
☐ 2. **Rising Sea**	☐ 7. **Bear's Shadow**	☐ 11. **Hide and Seek Moon**	☐ 16. **Stomp Rockets**
☐ 3. **Pocket Solar System**	☐ 8. **Ice Orbs**	☐ 12. **Filtered Light**	☐ 17. **Mars Rovers**
☐ 4. **Orbiting Objects**	☐ 9. **Solar Eclipse**	☐ 13. **Craters**	☐ 18. **Pack a Space Telescope**
☐ 5. **Investigating Clouds**		☐ 14. **Exoplanet Transits**	☐ 19. **Magnetic Fields**

NEXT

1

EXPLORE SCIENCE Earth & Space

Event Description Form

7. Please enter the initials of **everyone** on your team collecting data today next to their first and last names. **Circle** your initials. (Example: ZK = Zdanna King)

During event

8. **How busy does the event feel overall? Check one.**

☐High = Crowded. To move in the space, you need to step out of people's way.
☐Moderate = Many people in space, but you can walk without being impeded.
☐Low = Not many people. You are very unlikely to bump into someone.

9. **What types of groups do you see attending? Check all that apply.**

☐Family groups
☐Adult-only groups
☐School groups (or other large groups of children)

After event

10. **How many family cases did you collect at the event? ________________**
(Note: All of the instruments from one visiting group equal one family case. If there is only one survey from a group, this still counts as a family case.)

11. **What were some challenges to collecting visitor data at this event?**

2

Appendix F. Observation Codebook

Table 23. Observation Codes for How the Public May Engage Like Scientists

Behavior Codes	When to attribute or not attribute a code
Looked at something closely	Includes reading supplemental information and peering closely at activity for 3+ secs; Does not include reading the instructions.
Seemed to play/use imagination	On or off topic exploration that seems to be about finding out about the materials (running hands through the sand, adjusting the light and listening for the squeak of the lamp), adding humor or a light-hearted element to the activity, pretending the objects are something else or making comparisons to something in their everyday lives.
Explored an idea	On topic completion of an objective in the activity. Can also be the completion of an objective that they come up with that is on topic.
Did a hands-on action	Whenever they use their hands to manipulate a material in order to see or make something happen. Does not include writing notes or measurements, or using fingers or hands to point to things.
Worked with someone else	If they are working alongside someone and occasionally chat with them about the activity, this counts. We would not count this if people paid no attention to the other person. This would be if they worked completely separately on the activity and didn't look at each other's work, share what they were doing, or offer acknowledgement or advice of any kind.
Shared a discovery	If someone says "ah!" or "look at this!" while someone is also at the activity this counts. If they share an example of what they noticed or learned, this counts. It can really be any other person at the activity, too – a facilitator, a person from their group, or a stranger also doing the activity. If they are doing any of the above, but there is no one else at the activity, then this does not count.
Frequency Codes	Indicate frequency only if you observed a behavior.
High	3 or more times = High frequency; EXCEPTION: 2 or more times for Explored an Idea = High
Low	1-2 times = Low frequency (with the exception above)

Appendix G. Supplemental Findings

Additional findings from the summative evaluation summary are provided below, because we recognize that some stakeholders may want more detail. Topics covered below include more about how the PSdep statistic was calculated and how it should be interpreted, how SMD content was made available to visitors through the activities being presented during data collections, more specifics about changes in confidence ratings around the four SMD content areas, and more information about how subgroups of visitors responded to the close-ended question rating how much they were able to do different actions at the activities.

Calculating and interpreting effect size

In our sample, we collected measures from the same person, asking them to reflect on how confident they felt both before and after trying the activities on a scale from 1 to 4, which means that our samples are related, nonparametric, and ordinal. A search for within-group, nonparametric statistics for measuring effect sizes revealed several options, and the Grissom & Kim (2012) PSdep statistic seemed the most appropriate for our data and the most straightforward for interpretation.

To calculate the PS_{dep}, we counted the number of positive rank increases and divided them by our total number of matched pairs for each statement. Positive rank increases happened anytime a visitor responded that they were more confident sharing content with others after trying the activities. So, for example, here is the data for the statement, "Share at least one way that scientists are studying other planets": we have a total of 208 matched responses, and 96 of these showed positive increases (101 were the same before and after, and 11 decreased). To calculate the effect size using PS_{dep}, use the total number of positive rank increases ($n_+ = 96$) and divide this by total number of matched responses ($N = 208$) for a PS_{dep} value of 0.46.

This value can then be interpreted that there is a 46% chance that visitors will feel more confident sharing at least one way that scientists are studying other planets after trying the activities (Grissom & Kim, 2012; Social Science Club, 2016).

Additional Findings

How prevalent SMD content areas were in the activities available to the public during data collection

The project team identified how each of the activities represented each of the four SMD content areas during kit development (see Table 21). During our data collections for this study, activities with astrophysics content were available most often (83 times), while heliophysics was the least represented content area (27 times) (see Table 24).

Table 24. Activities present by SMD content area.

SMD Content Area	Times available
Astrophysics	83 times
Planetary science	65 times
Earth science	53 times
Heliophysics	27 times

Raw changes in confidence ratings for each action statement
On page 19, Table 16, we provided a summary table of the confidence ratings, changes in mean confidence ratings, and PS_{dep} statistics. We have also included below several tables broken out by raw changes in confidence around each of the five action statements. See Tables 25-29 below for percentages of rankings before and after trying the activities, along with the net change in ratings.

Table 25. "Share at least one way that scientists are studying other planets."

Confidence Rating	% Before (n=213)	% After (n=208)	Difference
Extremely Confident	13%	24%	+11%
Confident	37%	51%	+14%
Somewhat confident	38%	23%	-15%
Not at all confident	12%	2%	-10%

Table 26. "Describe at least one way that the Sun interacts with the Earth and the solar system."

Confidence Rating	% Before (n=209)	% After (n=206)	Difference
Extremely Confident	17%	28%	+11%
Confident	44%	49%	+5%
Somewhat confident	33%	22%	-11%
Not at all confident	6%	1%	-5%

Table 27. "Tell a friend at least one way that planet Earth is constantly changing."

Confidence Rating	%Before(n=210)	%After(n=207)	Difference
Extremely Confident	19%	28%	+9%
Confident	49%	51%	+2%
Somewhat confident	26%	19%	-7%
Not at all confident	7%	2%	-5%

Table 28. "Describe how tools reveal energy and forces at work in the universe."

Confidence Rating	%Before(n=210)	%After(n=205)	Difference
Extremely Confident	12%	22%	+10%
Confident	34%	46%	+12%
Somewhat confident	35%	25%	-10%
Not at all confident	19%	6%	-13%

Table 29. "Share at least one way that people are choosing to explore Earth and Space."

Confidence Rating	%Before(n=209)	%After(n=201)	Difference
Extremely Confident	19%	29%	+10%
Confident	40%	47%	+7%
Somewhat confident	34%	24%	-10%
Not at all confident	6%	<1%	-5%

Complete responses from action ratings

We asked adults, "At the activities, how much did your group get to do each of the following?" and listed each of the behaviors in the table below (see Table X). We also asked children to, "...think about the Earth and space activities you just tried. At the activities, how much did you get to do each of the following?" for the same list of behaviors. All respondents ranked if they were able to do something "a lot", "a little", or "not at all". While we provided a summary table (Table 20) comparing ratings of "a lot" for each of the actions we asked visitors about on page 23, we felt that some stakeholders would want a more detailed breakdown of these ratings (see Table 30).

Table 30. Percentage of respondents who selected that they did each of the following behaviors

Behaviors	A lot		A little		Not at all	
	Adults	Children	Adults	Children	Adults	Children
Do something hands on to learn more (n=236 adults, n=141 children)	89%	73%	11%	22%	-	5%
Look at something closely (n=237 adults, n=142 children)	81%	61%	18%	37%	1%	2%
Share a discovery (n=239 adults, n=138 children)	72%	53%	26%	27%	2%	20%
Play and use your imagination (n=238 adults, n=142 children)	71%	60%	28%	30%	2%	11%
Choose ideas to explore (n=235 adults, n=143 children)	64%	52%	33%	31%	3%	17%
Work together* (n=237 adults, n=140 children)	60%	50%	36%	33%	4%	17%

*For children, this statement read "work together with my group".

A total of 18 out of 242 adults marked that their groups were not at all able to do at least one of behaviors above. We have data about the number of activities that thirteen of these respondents reported stopping at, which ranged from trying 3 to 9 activities and averaging about 4 activities. About a third of child respondents (55 out of 144) reported that they were "not at all" able to do at least one of the behaviors above. We have visitation data for fifty-four of the children; most had stopped at about 4 activities (ranging from 1 to 9). See Table 31 below for which activities adults and children stopped at when they gave the "not at all" ratings for how much they were able to do each of the behaviors.

Table 31. Activities that visitors stopped at when they also marked that they were "not at all" able to do at least one of the listed behaviors.

Activity	Activities stopped at	
	Adults (n=13)	Children (n=54)
Magnetic Fields	10	35
Craters	9	30
Filtered Light	7	22
Mars Rover	6	24
Exoplanet Transits	5	16
Paper Mountains	5	21
Objects in Motion	5	14
Pack a Space Telescope	4	15
Stomp Rockets	4	11
Hide and Seek Moon	4	21
Ice Orbs	1	11
Pocket Solar System	-	5
Orbiting Objects	-	4
Imagining Life	-	2

Finally, we wanted to explore whether younger children were developmentally able to answer this question. We removed the comments of respondents who skipped answering the age question, then split responses by age for the remaining cases into two subgroups; children from three through seven years old, and children ages eight through fourteen. Younger children still showed variation in their responses (see Table 32); they did not check all one thing but seemed to reflect the same kinds of differences in their ratings as older children. What we observed with groups answering surveys is that young children often had the support of older group members to interpret and respond to the surveys, and this may have affected how young children answered this question.

*Table 32. Percentage of younger vs older children who selected that they did each of the following behaviors**

Behaviors	A lot		A little		Not at all	
	Younger	Older	Younger	Older	Younger	Older
Do something hands on to learn more (n=58 younger children; n=78 older children)	**88%**	65%	12%	**28%**	-	**6%**
Look at something closely (n=57 younger children; n=79 older children)	**74%**	53%	26%	**43%**	-	**4%**
Share a discovery n=56 younger children; n=77 older children)	**63%**	47%	25%	**29%**	13%	**25%**
Play and use your imagination (n=58 younger children; n=78 older children)	**67%**	55%	24%	**35%**	9%	**10%**
Choose ideas to explore (n=58 younger children; n=80 older children)	**59%**	50%	24%	**36%**	**17%**	14%
Work together with my group (n=58 younger children; n=77 older children)	**53%**	49%	**36%**	30%	10%	**21%**

*Younger children recorded ages between 3 and 7. Older children recorded ages between 8 and 14.