Build a Mars Habitat: Survive and Thrive Project

Summative Evaluation Report

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Compiled by:
Gretchen Haupt (she/her)
Elena Tsakakis (she/her)

Science Museum of Minnesota®

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Executive Summary

Build a Mars Habitat (Survive and Thrive) is a National Informal STEM Education Network (NISE Network) project, led by the Science Museum of Minnesota (SMM). This three-year NASA TEAM II project was designed in partnership with museum educators and NASA subject matter experts to educate and inspire visitors about human exploration of Mars. The exhibit developed from this work, *Build a Human Habitat on Mars,* allows visitors to design and construct their own imaginary habitat for successful living and working on Mars. Fifty-two copies of the exhibit have been designed and fabricated as an addition to the 52 copies of the *Sun, Earth, Universe* exhibition located throughout the United States.

The summative evaluation of the *Build a Human Habitat on Mars* exhibit explored the public's learning, interest, and engagement with the activity. The evaluation questions included:

1) What does visitor engagement look like with regards to activity enjoyment and interest?
2) How relevant is the exhibit to visitors' everyday life?
3) To what degree does the exhibit foster 21st Century Skills?

The target audience for the Build a Mars Habitat Project was families with children ages 9-14 (grades 4th-8th). The evaluation team collected data at partner sites throughout the country that received the *Build a Human Habitat on Mars* exhibit

Summary of findings

I. The *Build a Human Habitat on Mars* exhibit was enjoyable, interesting, and educational for visitors, and increased interest in learning about space exploration.
    - Almost all groups (95%) found the exhibit enjoyable or very enjoyable, and 90% of groups shared that the exhibit was interesting or very interesting.
    - After visiting the exhibit, three-quarters of groups noted their interest in learning about space exploration increased somewhat or a lot.
    - Visitors who learned something new were more likely to enjoy the exhibit and find it interesting, demonstrating the connection between content and the overall experience at the exhibit.
    - Groups with children of all ages found the exhibit interesting and enjoyable; having a broader age range within the group may contribute to an even higher quality experience.
    - Almost 80% of groups learned something new from using the *Build a Human Habitat on Mars* exhibit, and nearly a third of visitors expressed awareness of what was required to live on Mars. Visitors demonstrated an understanding of basic necessities that would allow for humans to survive in a non-habitable environment.
    - Groups stayed at the exhibit for an average of 20 minutes, with half of groups staying longer than that.

II. The *Build a Human Habitat on Mars* exhibit provided visitors with clear connections to their everyday life and promoted reflection on the idea of 'survive and thrive'.
    - Just under 40% of visitors mentioned essential needs when considering how the exhibit connected to their everyday life. The frequency of responses related to these essential needs indicates a deeper understanding of what fundamental items underpin their daily life and contribute to well-being.

- More than a third of visitors connected the exhibit with familiar, everyday items at home. These connections may indicate participants' recognition around how items that promote well-being, belonging, and normalcy can be important in unfamiliar settings.
- Visitors gained a deeper understanding of what is necessary to survive and thrive on Mars. After using the exhibit, about two-thirds of respondents shared that they were more confident than before in their ability to identify what humans would need to survive and thrive on Mars.

III. The *Build a Human Habitat on Mars* exhibit effectively supported problem-solving, collaboration, and creativity in various ways.

- All visitors were observed to engage in problem-solving behaviors while using the exhibit.
- Similarly, nearly every observed group (99%) was noted to engage in collaboration, most frequently observed to be scaffolding the activity, sharing ideas, and working together to understand where to get started.
- The majority of observed groups also engaged in creativity while using the exhibit (90%), with more than three-quarters of participant groups engaged in 'imagining' while using the exhibit.
- Most visitors (60%) increased in their confidence to explain how teamwork is important to surviving on Mars after using the exhibition comparison to their confidence prior.

Introduction

The Build A Mars Habitat (Survive and Thrive) project was designed in collaboration with NASA subject matter experts and museum educators to inspire, engage, and educate the next generation about exploration of Mars. The exhibit component was designed to engage audiences in STEM learning related to space exploration, with a focus on fostering 21st century skills such as creativity, problem-solving, and collaboration. The exhibit materials and content provide an interactive experience for visitors to explore building and living in a Mars habitat. The *Build a Human Habitat on Mars* exhibit was designed to fit within the existing *Sun Earth Universe* exhibition designed by the NISE Network in 2019.

Exhibit Description

Build a Human Habitat on Mars is a hands-on exhibit designed to inspire, engage, and educate the next generation of explorers about human exploration on Mars. For people to live on Mars, we will need to develop technology and systems that will allow humans to survive and thrive. Survival means there are processes in place to maintain the bare minimum for human life to exist: water to drink, oxygen to breathe, shelter from the harsh environment, and much more. Thriving on Mars requires making special efforts to stay healthy both physically and mentally. This means having resources to keep your mind and body active, like your favorite book, music, comfort foods, hobbies, exercise, and ways that allow you to transition your day-to-day routines to a new and very different planet from our own.

Build a Human Habitat on Mars utilizes Strictly Briks® building blocks, which are compatible with other major brick brands, and allows museum visitors to immediately be able to design and construct their own imaginary habitat for successful living and working on Mars. By using a familiar resource, participants can focus on the real challenges to life on Mars and have thoughtful reflection about possible solutions. The exhibit also includes a set of challenge cards presenting some of the very real hardships people will face when establishing an outpost on Mars. Wanted: explorers and creative thinkers who can survive, thrive, and *Build a Human Habitat on Mars*!

The exhibit component is designed to be integrated into the *Sun, Earth, Universe* exhibition. Fifty-two copies of the exhibit have been designed and fabricated as an addition to the 52 copies of the *Sun, Earth, Universe* exhibition located throughout the United States.

More information about the project: https://www.nisenet.org/mars-habitat-project

Educator guide and host resources: https://www.nisenet.org/marshabitat

Learning Goals and Target Audience

The primary goal of the *Build a Human Habitat on Mars* exhibit is to engage public audiences in authentic STEM learning related to space exploration and to foster 21st Century Skills such as creativity, problem-solving, and collaboration.

STEM Learning Outcomes

- Increased interest and positive attitudes related to learning about space exploration
- Gain in content knowledge about space exploration, science, and engineering
- Fostering 21st Century Skills such as creativity, problem-solving, and collaboration.

Learning Objectives

Primary learning objectives are related to STEM processes and STEM identity. Learners will:

- Work together to accomplish goals and solve problems
- Identify as someone who can learn about and participate in Earth and space exploration

Additional learning objectives are related to greater understanding of key concepts in human exploration beyond low-Earth orbit and lunar/planetary science. To ensure that the exhibit accurately represents key aspects of human exploration of Mars, the project team collaborated with NASA subject matter experts and drew upon content from planned missions, new technology, and the emerging challenges of future human space exploration.

Learning Framework

The Learning framework is consistent with that established for other NISE Network Earth and Space programming:

- Experience Earth and space phenomena and explore scientific discoveries.
- Use the scientific process and reflect on science as a way of knowing.
- Participate in the scientific community and identify as a science learner.

Target Audience

Build a Human Habitat on Mars was designed for students in grades 4-8. However, using a very familiar, all-ages building resource, the exhibit is widely accessible to family audiences of all ages and backgrounds, school field trip groups, underserved audiences, and more.

Evaluation Questions

The evaluation team used the project outcomes and learning framework, as well as conversations with the project team and NSF impact categories, to identify evaluation questions and instruments specific to the Build a Mars Habitat (Survive and Thrive) project goals. These questions guided the summative evaluation planning and instrument development.

1. What does visitor engagement look like with regards to activity enjoyment and interest (NSF Impact Category: Engagement/Interest)?

2. How relevant is the exhibit to visitors' everyday life (NSF Impact Category: Awareness, knowledge, or understanding)?

3. To what degree does the exhibit foster 21st Century Skills (NSF Impact Category: Skills)?

Methods

Data Collection Methods & Sampling

Data was collected across five sites; Science Museum of Minnesota (SMM), Arecibo Observatory, Museum of Science Boston (MOS), Children's Museum of Brownsville, and Arizona Science Center. At SMM, trained evaluators collected observations and matched surveys. At the four partner sites, surveys were collected remotely using posted QR codes. Surveys at all sites were offered in both Spanish and English.

In total, there were 126 surveys collected from adults. There were 70 surveys matched with 70 observations from SMM, and 56 surveys collected remotely from partner sites. There were no observations conducted at partner sites. There were 12 surveys collected in Spanish, all from partner sites.

Table 1. Overview of evaluation sites

Location	Data Collected	# surveys	# observations
Science Museum of Minnesota (SMM) Saint Paul, MN	Observations and matched surveys	70	70
Arecibo Observatory Arecibo, Puerto Rico	Surveys	7	0
Museum of Science Boston, MA	Surveys	16	0
Children's Museum of Brownsville Brownsville, TX	Surveys	23	0
Arizona Science Center Phoenix, AZ	Surveys	25	0

Data Collection at Science Museum of Minnesota

The evaluation team conducted cued observations with matched surveys at the Science Museum of Minnesota.

Cued Observations: Cued observations focused on identifying if and how the exhibit supports 21st Century Skills, and describing what engagement looks like with regards to interest and enjoyment. Trained SMM evaluation staff began observations by setting up the observation area, which was indicated by placing stanchions and signage around the *Build a Human Habitat on Mars* exhibit (Figure 1). This was to discourage non-participating visitors from using the exhibit during the observation. Staff used a continuous, random sampling technique using the "invisible line" method to approach every group that appeared to meet eligibility criteria – at least one adult and one child in 4th-8th grade (appears to be between 9 and 14 years old).

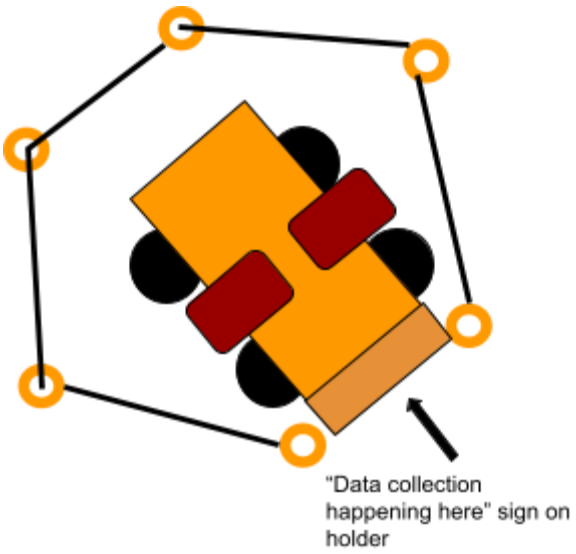


Figure 1. The *Build a Human Habitat on Mars* exhibit with stanchions sectioning off the data collection area. A sign that said "Area Under Observation" was placed behind the exhibit's large graphic sign.

After bringing the participating group to the exhibit, SMM evaluation staff briefly explained that this is an activity about building human habitats on Mars, and evaluators are observing how people use it so we can describe the outcomes to NASA, the funder for the activity. They let the group know that the staff member will be standing nearby observing and taking notes, encouraged group members to think out loud, and assured that nothing recorded will be identifiable information. They were also told that there is no right or wrong way to use the activity, they can use the activity for as little or as long as they'd like, can work together or individually, and may ask any question during or after the activity. Groups were asked to let the staff member know when they were done to participate in a brief follow-up survey.

SMM evaluation staff recorded the de-identified case ID, start time, and group size/make-up, and made notes about 21st Century skills behaviors that came up throughout, as well as other potentially relevant notes about how groups were engaging together and with the materials. The observation instrument used by evaluators included a chart of target behaviors to look for, with space for observers to note what this behavior looked like within a particular group (Appendix B). The target behaviors provided were: Hands-on Learning, Look at Something Closely, Play/Imagine, Building, Testing, Problem-solving, and Sharing with Others. Evaluators noted if and how 21st Century Skills were displayed during those behaviors. Additional pages were provided for observers to record the general narrative of the observation, using the guiding questions: What does visitor engagement look like with regards to activity enjoyment and interest? How are groups talking about 'survive' and 'thrive'? Are they using the challenge cards? How many? In what ways?

Follow-up questions: After the group signaled that they were done, the SMM evaluation staff asked any clarifying questions that came up during the observation, such as what they built and their intentions behind designs. SMM evaluation staff then asked one closed and two open-ended questions, which were: 1) Did you or your group learn anything new at the exhibit? (*Yes/No/Unsure*), 2) If yes, what are 1 or 2 things that you or your group learned about? (*Open-ended or skipped if they answered "No"*), 3) What in your daily life connects to something you saw in this exhibit? (*Open-ended*)

Survey: After the staff-directed follow-up questions are complete, at least one adult (18+) is asked to respond to a questionnaire on a tablet in collaboration with other group members (Appendix B). All members of the group (including kids not in the target range) were told they can work together to contribute responses. SMM evaluation staff stood nearby to answer any questions as they came up. After they completed the survey, the SMM evaluation staff member thanked the group for their time and distributed the $10 incentive.

The summative evaluation survey consisted of closed- and open-ended questions focused on visitor self reports of interest, enjoyment, and opportunities to use 21st Century Skills. The survey also included questions about relevance, knowledge, and understanding. Instruments were based on the summative evaluation of the *Sun, Earth, Universe* exhibition that occurred in 2019.

Data collections at partner sites

Arecibo Observatory, Museum of Science, Children's Museum of Brownsville, and Arizona Science Center each posted a site-specific QR code next to the exhibit for visitors to access through their own devices (Appendix C). This survey was the same survey across all sites, and the same survey that was administered onsite at SMM, with the addition of the three follow up questions asked of SMM participants . No staff members were directing visitors to use the exhibit or scan the QR code. Survey respondents had the option to enter their contact information after the survey to receive a $10 gift card by mail.

Data analysis and Human Subjects Protections

Descriptive statistics were conducted for the close-ended survey questions and demographics. The open-ended survey questions were reviewed and coded thematically using emergent codes. Relevant crosstabs were conducted using Statistical Package for Social Sciences (SPSS) software. Observational data from SMM was coded thematically using emergent codes related to the core 21st Century skills (collaboration, creativity, and problem-solving). The codebooks are available in Appendix A.

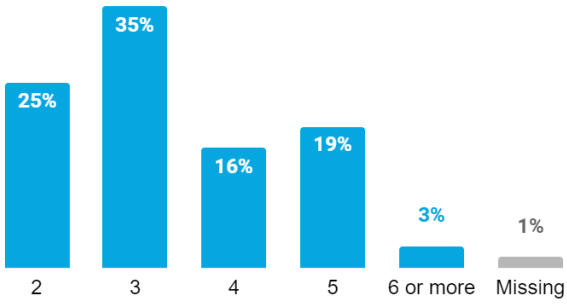
Consent was provided in-person on the floor for the observations at the Science Museum of Minnesota. Remote survey participants provided passive consent when clicking to take the survey.

Participant demographics

Observed Group Composition

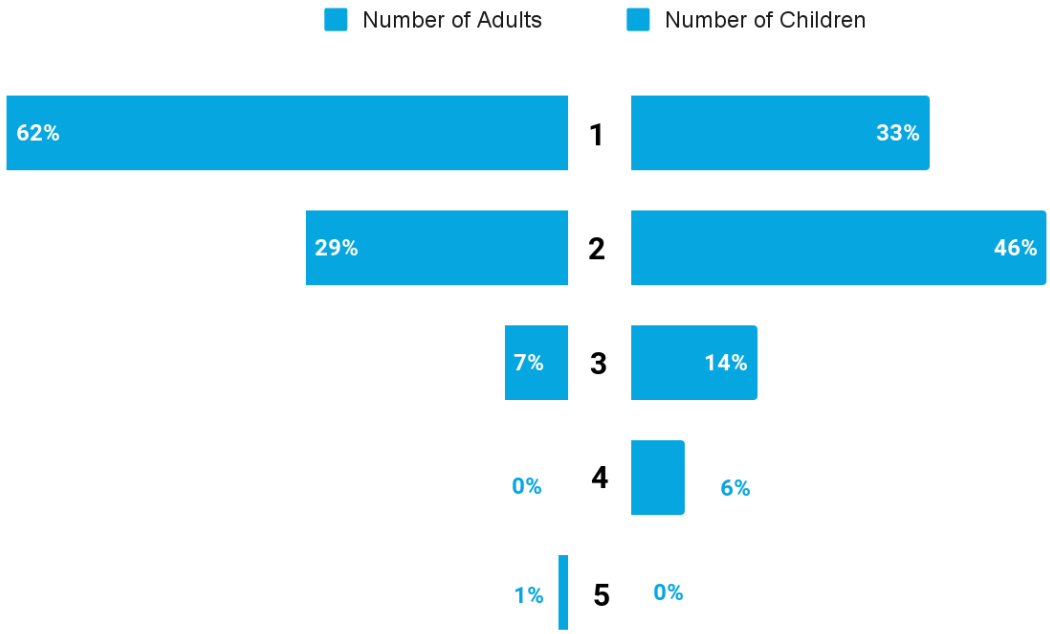
Observers at the Science Museum of Minnesota noted group composition during the observation. All groups at Science Museum of Minnesota (SMM) included at least one adult and one child between the ages 9-13 years old. About 25% of groups consisted of the minimum number of adult and child participants, but a majority of groups (60%) included two to three participants (Figure 2).

Figure 2. Number of people in Science Museum of Minnesota groups (n=68)



Most often, groups included only one adult participating in the cued observation. Over a quarter of groups (29%) included two participating adults (Figure 3), with the remaining groups including three or five adult members (7% and 1%; Figure 3). While most groups tended to include only one adult, groups most frequently included two children (46%; Figure 3). These groups could include both children within the target age range, or one child outside the 9-13 age range. However, groups were less likely to include more than two children, and only a third (33%) of participant groups had only one child take part in the *Build a Human Habitat on Mars* exhibit observation (Figure 3).

Figure 3. Number of adults and children per group at Science Museum of Minnesota (n=68)



Group Demographics

We are presenting group level demographic data only from respondents who participated in the study at SMM[1]. Survey responses from all 126 respondents are incorporated into the findings section below.

The distribution of children's genders in participant groups at SMM indicates that over half of groups (57%) included girls either exclusively (Girls only) or alongside boys (Mixed), but about two-thirds of groups (67%) included boys exclusively (Boys only) or alongside girls in the group (Mixed; Figure 4). In other words, 57% of groups included at least one girl, and 67% included at least one boy. As shown in Figure 4, since nearly a third (32%) of groups had a mix of both boys and girls participating, this sample included a higher percentage of groups with only boys (35%) compared to groups with only girls (25%). Additionally, a small percentage of these observations (7%) were missing gender distribution data.

Figure 4. Gender distribution of children in SMM groups (n=68)

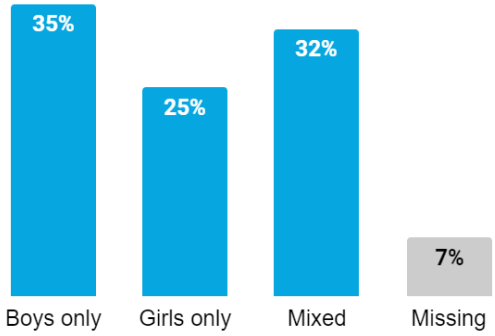
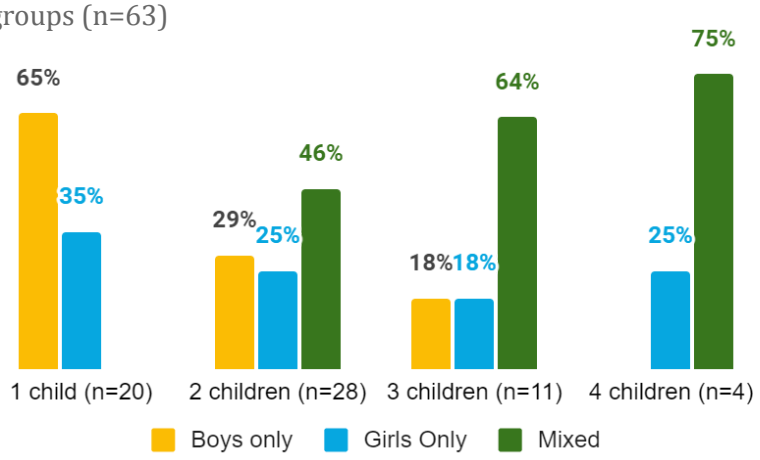


Figure 5. Gender distribution and number of children in SMM groups (n=63)



In groups with only one child participant, a larger percentage of children were boys (65%) compared to girls (35%; Figure 5). Groups with two or more children were more likely to have both boy and girl participants. Groups with two or three children had similar distributions of boys only and girls only groups, while groups with three or four participating children were more likely to include only girls rather than only boys (Figure 5).

Just under two-thirds of groups at SMM (58%) included only children in the target range of 9-14 (Figure 6), while 44% of groups at SMM included at least one child who was younger than nine. Only 6% of groups at SMM included a child who was older than the target age range.

[1] At SMM, survey respondents were asked to report the age and gender of others in their group. The survey was supported by evaluation staff at SMM, and evaluation staff noted observed demographics to confirm accuracy of the reported information. Participants at remote collection sites were invited to provide demographics on their group, but without staff support, responses to this section were inconsistent and deemed unreliable.

Figure 6. Ages of children in SMM groups (n=62)

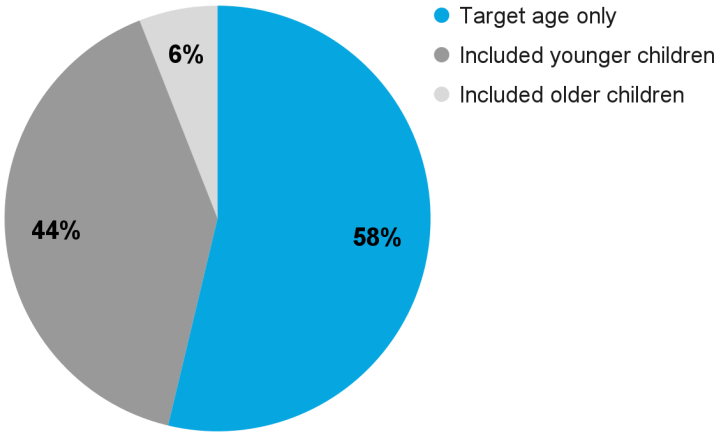
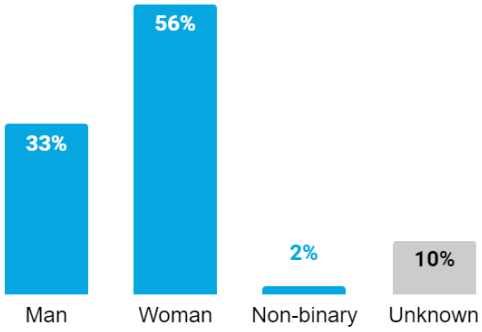


Figure 7. Gender of person completing survey (n=126)



Survey Respondent Demographics

Across all surveys collected following the cued observations at SMM and via QR code at partner sites, respondents provided demographic information for themself as the primary survey respondent. The survey respondent was an adult (18 years old or older). This demographic section includes only self-reported demographic information from the individual survey respondent across all five data collection sites. A majority of respondents (56%) identified as women, with only a third of respondents (33%) identifying as men (Figure 7). While a small percentage of respondents (2%) identified as non-binary, the gender identity of 10% of respondents is unknown because they either skipped the question or selected "Prefer not to say."

Over a third of respondents (36%) in this sample identified as BIPOC (Figure 8), with the largest proportion of Black, Indigenous, and People of Color (BIPOC) respondents identifying as Hispanic or Latino/a/x (Table 2). Additionally, the race or ethnicity of 10% of respondents is unknown.

Figure 8. Race/ethnicity of person completing the survey (n=126)

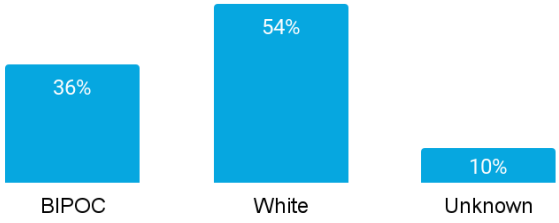


Table 2: Breakdown of BIPOC group (n=51)	
American Indian or Alaskan Native	5 (10%)
Asian or Asian American	3 (6%)
Black or African American	7 (14%)
Hispanic or Latino/a/x	24 (47%)
Multiple selected	6 (12%)

Findings

The findings presented below include survey responses from all 126 participants, and observations from the 70 visitors who participated in the study at the Science Museum of Minnesota.

I. What does visitor engagement look like with regards to activity enjoyment and interest?

Groups stayed at the *Build a Human Habitat on Mars* exhibit for an average of 20 minutes, and most groups shared facilitation responsibilities between children and adults.

While groups may have felt less pressure to conclude their time with the activity since they had exclusive use of the exhibit, summative dwell time data is consistent with findings from the formative study and further demonstrates that the *Build a Human Habitat on Mars* exhibits a very "sticky" activity. The average engagement time at the exhibit was 20 minutes, and half of the groups observed stayed longer than 20 minutes (Figure 9). As shown in Figure 10, groups which included younger or older children had a slightly higher average dwell time at the exhibit. Only two groups spent less than five minutes at the exhibit and the group with the longest stay time was engaged for 47 minutes.

Figure 9. Observed dwell time at the *Build a Human Habitat on Mars* exhibit, in minutes (n=68)

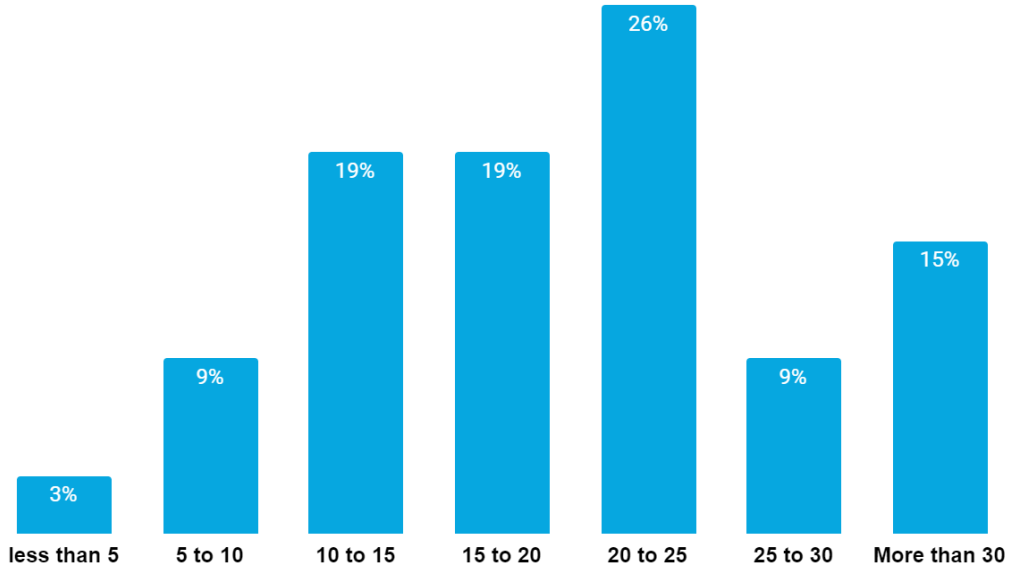


Figure 10. Average dwell time at the *Build a Human Habitat on Mars* exhibit, in minutes, based on group composition

Groups engaged in a variety of behaviors such as iterating, imagining, and scaffolding while using the *Build a Human Habitat on Mars* exhibit.

Overall, nearly three-fourths of participant groups were observed 'iterating' (78% - building something, testing it out, and then changing or refining the original build), 'imagining' (76% - discussing possible scenarios or giving materials a different meaning or specifying use), 'scaffolding' (74% - starting or continuing a conversation with the intent to support and guide building); and referencing the instructions (72% - returning to the main graphic signage and the challenge cards to consult and guide building decisions; Table 3). It is worth noting that it was often difficult to hear specifically what participants discussed with each other while they worked. So, coded behaviors that relied on interpreting content of conversations ('Help,' 'Humor,' 'Planning') may under-represent what was actually discussed. Code definitions of the behavior codes are available in Appendix A.

Table 3. Frequency of behaviors observed at the *Build a Human Habitat on Mars* exhibit (n=68)

Half or more of groups		**Fewer than half of groups**	
Iterating	78%	Worked together on shared structure	40%
Imagining	76%	Sorting	40%
Scaffolding	74%	Life on Mars	38%
Instructions	72%	Testing	38%
Sharing ideas	65%	Planning	35%
Getting started	63%	Humor	31%
Design and layout	54%	Help	29%
Worked together on separate structures	50%	Connections	28%

The behaviors above are part of a larger coding scheme intended to describe behaviors that related to the three 21st Century Skills the exhibit was intended to support: "Collaboration," "Problem-solving," and "Creativity." A deeper discussion on pages 25-27 highlights how well the exhibit supported these three 21st Century Skills based on observed behaviors.

Groups with children of all ages found the exhibit interesting and enjoyable.

Nearly all groups (95%) found the exhibit enjoyable, with just under half indicating that the exhibit was very enjoyable (Figure 11). Similarly, the majority of participating groups found the exhibit interesting or very interesting (Figure 12).

Figure 11. Distribution of how enjoyable participant groups found the exhibit (n=126)

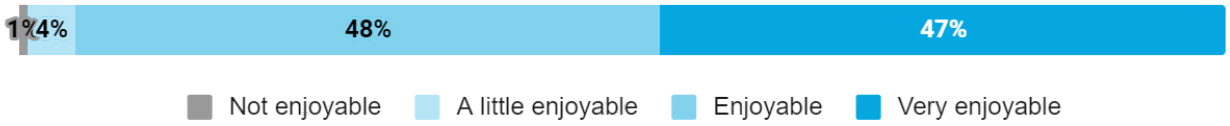


Figure 12. Distribution of how interesting participant groups found the exhibit (n=126)

All groups included at least one child in the target age range, but observations at SMM noted when groups also included children older or younger. This allows us to disaggregate responses by age group for respondents from SMM. Generally, interest and enjoyment remained high among all categories when disaggregating groups by age composition, demonstrating that the exhibit is enjoyable, interesting, and educational for children both in and outside of the target age range.

While the target audience for the exhibit is children in 4th-8th grade, the experience is also enjoyable and interesting among groups with additional child participants outside the target age group. In fact having a broader range of ages may contribute to an even higher quality experience (Figures 13 and 14).

Figure 13. Distribution of how enjoyable observed participant groups found the exhibit based on the age composition of child group members

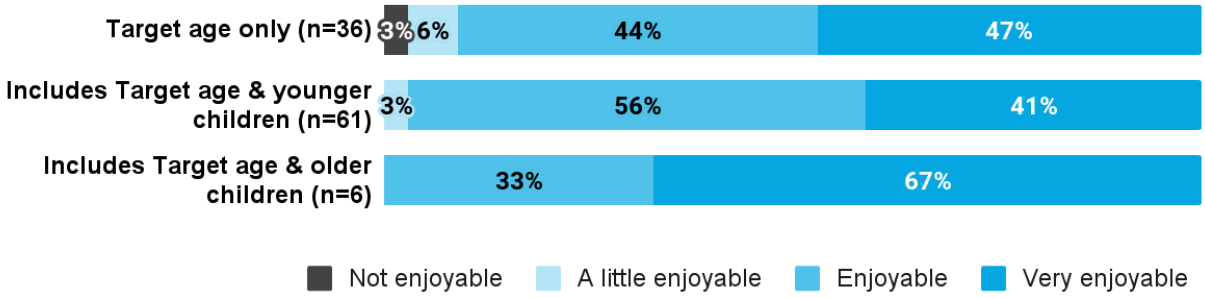
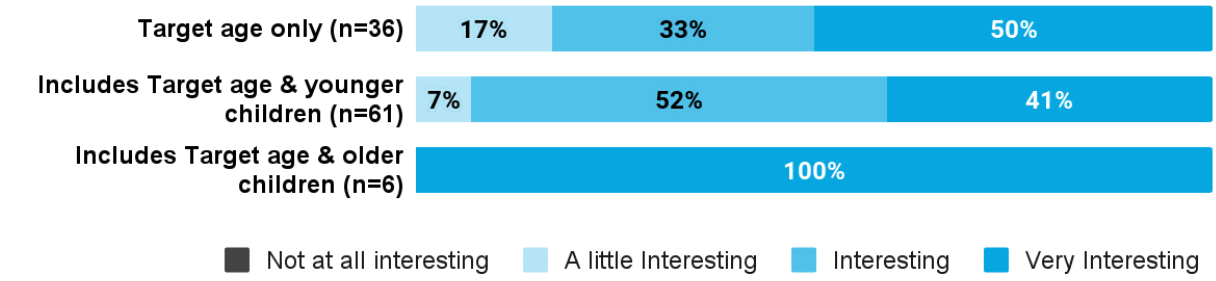


Figure 14. Distribution of how interesting observed participant groups found the exhibit based on age composition of child group members



Visitors to the *Build a Human Habitat on Mars* exhibit learned something new, and were interested in learning more about space exploration.

More than a third of respondents shared that their interest in learning about space exploration increased 'a lot' after visiting the exhibit, and just under 40% shared that their interest increased somewhat (Figure 15). Only 3% of respondents indicated that they did not have an increased interest in learning about space exploration.

Figure 15. Distribution of increased interest in learning about space exploration after visiting the exhibit (n=126)

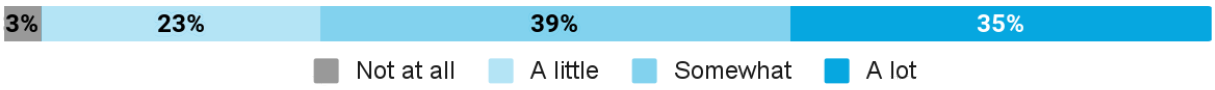
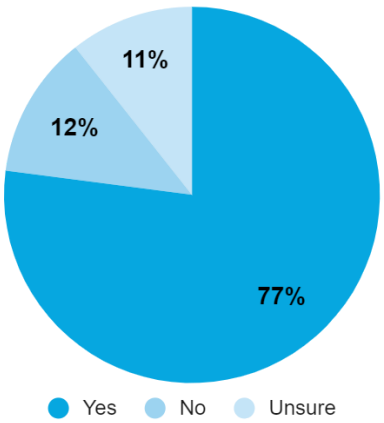
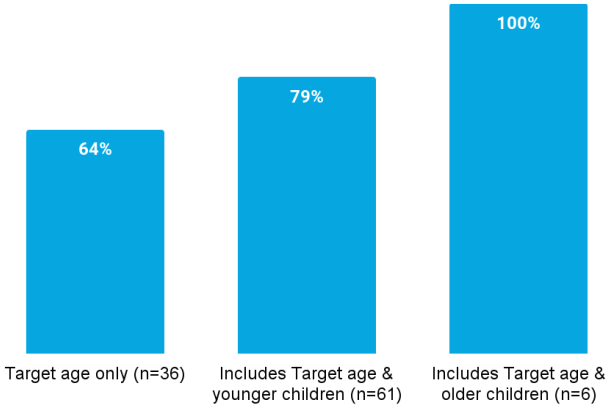


Figure 16. Distribution of whether visitor groups learned something new at the exhibit (n=122)



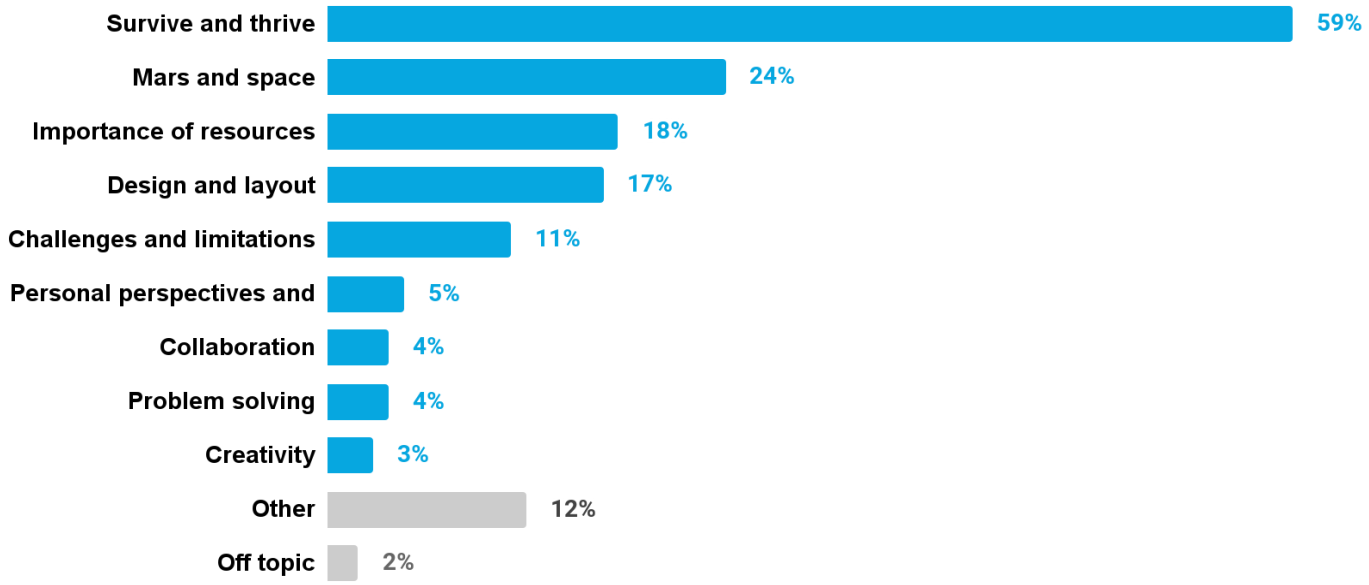
Similarly, nearly 80% of groups learned something new at the exhibit (Figure 16). Groups that included both children in the target age range and a child outside the target age range (either older or younger) more frequently agreed they learned something new; all groups that contained an older child agreed they learned something new, and nearly 80% of groups with a younger child agreed (Figure 17).

Figure 17. Percentage of visitor groups that learned something new based on group composition



Groups were asked to share what they learned during their time using the exhibit. The responses were coded into different themes, and the data reveals a range of learning experiences related to necessities to living and working on Mars and 21st century skills required to survive and thrive on a different planet. The complete interview response codebook of themes is included in Appendix A. Overall, participants most frequently shared that they learned something new related to surviving and thriving on Mars, Mars and space, and the importance of resources (Figure 18).

Figure 18. Distribution of learning codes described by participants (n=107)



Survive and Thrive

An overarching theme of "Survive and Thrive" emerged from participant responses as they highlighted the specific needs and constraints associated with living on Mars. and the requirements to survive and thrive on a different planet. Nearly 60% of visitor responses fell into this larger category around 'survive and thrive' (Fig. 18). Within this group, there were several key takeaways visitors noted.

- Almost a third of respondents expressed an awareness of the requirements for living in a non-habitable environment such as Mars. Participants mentioned the necessity of various items for survival, such as oxygen, water, and food, emphasizing the understanding of basic necessities. For example, one participant noted, "You need everything you need on this planet on other planets."
- Participants also recognized the need for additional resources, such as energy and communication systems, in order to thrive on Mars.
- Visitors discussed the importance of recreational items, such as movies, toys, or even bringing pets, to enhance their experience on Mars. These considerations showcased visitors' understanding of the distinction between mere survival and creating a habitat where they can truly thrive.

Mars and Space

Just under a fourth of respondents also shared their learning related to Mars and space exploration, including both factual knowledge and a deeper understanding of the unique requirements and conditions of living in space. Some examples of specific facts they had acquired were the duration of a trip from Earth to Mars, the existence of dust storms on Mars, and the lower temperature on the planet. Many participants also mentioned gaining insights into the differences between Earth and Mars and needing to adjust their thinking about certain items taken for granted on Earth, like the availability of oxygen for breathing, that are crucial for life on Mars.

Importance of Resources

Close to a fifth of participants acknowledged that living on Mars would require significantly more power, water, and oxygen compared to Earth. This understanding of the increased resource demands reflects an awareness of the challenges involved in surviving in an inhospitable environment. Additionally, the activity prompted some visitors to consider the value of recycling and waste management in a Martian habitat where resources are scarce indicating an understanding of sustainable practices in resource utilization. This realization was evident in the comments of participants who expressed surprise and curiosity about the processes involved in reusing waste products, such as converting urine and feces into resources and highlights a greater understanding of the importance of responsible resource management.

Design and Layout

Furthermore, the activity encouraged visitors to reflect on the balance between surviving and thriving within the design of their living space. As they meticulously planned the layout of their habitats, they had to consider the essentials needed for survival, such as oxygen, water, and power. For example, thinking about how structures should be connected to allow the flow of oxygen. However, they also recognized the importance of creating an environment that supports their overall well-being and quality of life, and creating space for leisure activities.

Participants who learned something new were more likely to enjoy the exhibit and find it interesting.

Overall, participant groups who indicated that they learned something new at the exhibit were more likely to find the exhibit interesting (Figure 19) and enjoyable (Figure 20) demonstrating that connection between content and their experience at the exhibit. Nearly all groups (98%) who shared they learned something new found the exhibit interesting or very interesting (Figure 19). Of those who didn't learn anything new, 40% indicated that they found the exhibit 'a little interesting'. Similarly, almost every group (99%) who learned something new indicated the exhibit was enjoyable or very enjoyable; of those who didn't learn anything new, 7% found the exhibit not at all enjoyable (Figure 20).

Figure 19. Participants groups who learned something new at the exhibit were more likely to find the exhibit very interesting

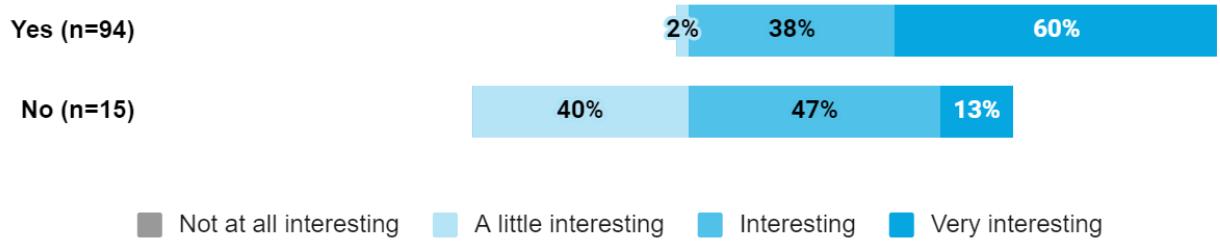
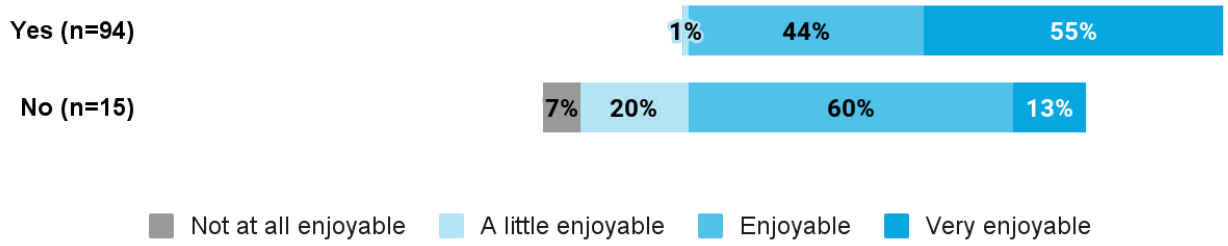


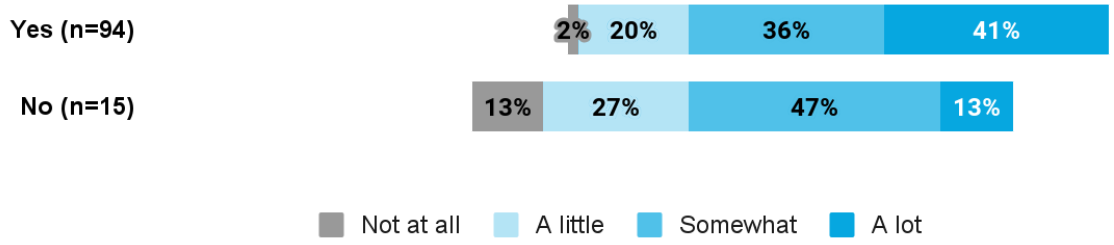
Figure 20. Participant groups who indicated learning something new at the exhibit were more likely to find the exhibit more enjoyable



Visitors' interest in learning about the human exploration of space increased after using the exhibit, and visitors who enjoyed the exhibit were more likely to share an increased interest.

Visitors also reflected on how their interest in space exploration changed after using the exhibit. In general, groups who indicated they learned something new from the exhibit more frequently shared that their interest in space exploration increased by 'a lot' (41%). However, even amongst those who didn't learn anything new from the exhibit, 60% still indicated their interest in space exploration increased somewhat or a lot (Figure 21).

Figure 21. Participant groups who indicated they learned something new at the exhibit were more likely to have an increased interest in learning about space exploration



In relation to interest, nearly 60% of groups who found the exhibit very interesting indicated their interest in space exploration increased by 'a lot' after using the exhibit, compared to only 15% of those who found the exhibit 'interesting' (Figure 22). This same trend was also reflected among respondents who found the activity 'very enjoyable'; over half (56%) shared that their interest in space exploration increased 'a lot' (Figure 23).

Figure 22. Participant groups who found the exhibit to be more interesting were more likely to have an increased interest in learning about space exploration

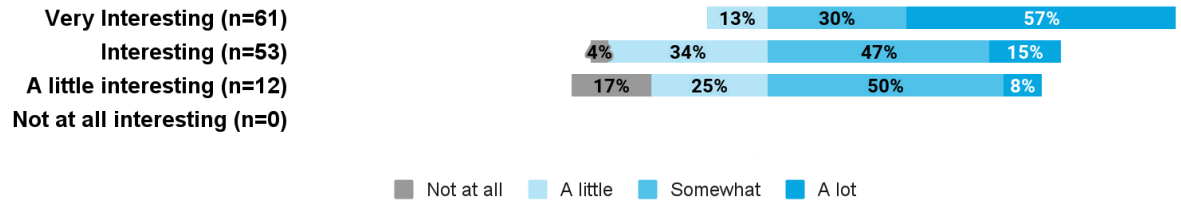
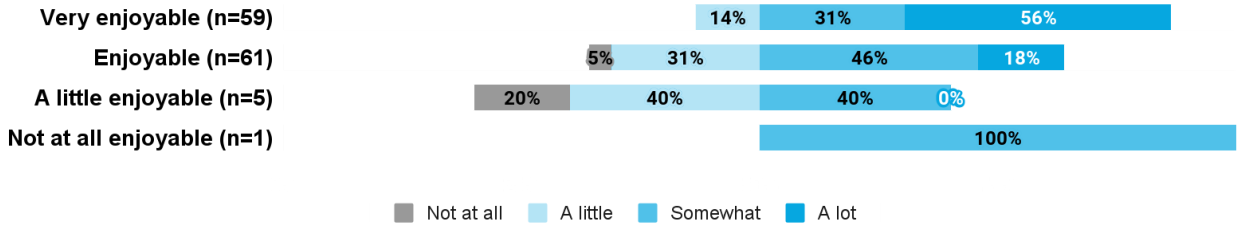


Figure 23. Participant groups who found the exhibit more enjoyable were more likely to have their interest in learning about space exploration increase 'A Lot'



II. How relevant is the exhibit to visitors' everyday life?

Groups recognized their essential needs and everyday items that would be important to build a sense of belonging and normalcy on Mars.

Participant groups were asked to reflect on how the exhibit connected to their everyday life. The responses were coded into thematic groups (see the codebook in Appendix A for full descriptions). Overall, three categories emerged when considering participants' comments about the ways the exhibit connected to their daily lives: "Surviving and thriving," "Personal experiences," and "21st Century Skills."

The first two groupings highlighting the significance of essential needs, personal interests, and the incorporation of familiar elements in envisioning life on Mars, are presented here. The discussion of daily life connections visitors made to 21st Century Skills continues on page 29.

Surviving and Thriving

Responses related to 'surviving and thriving' most frequently included ideas around essential needs and connections to their current home and everyday life.

Essential needs: The high frequency (38%) with which participants mentioned "essential needs" such as food, water, and power highlights the ways participants recognized the vital role these elements play in their everyday routines. For example, discussions about eating and using a bathroom emphasized the significance of nutrition, hygiene, and bodily functions in both terrestrial and extraterrestrial contexts. The frequency of responses related to essential needs indicates participants likely gained a deeper understanding of the fundamental requirements that underpin their daily lives and the essential role they play in fostering human well-being. By engaging with the exhibit and challenge cards, participants could reflect on the essential needs they often take for granted and gain a renewed appreciation for their significance.

Everyday life: Over a third of participants (35%) also described familiar everyday items they encounter at home in relating the exhibit to their everyday life. Mentions of beds, sofas, chairs, tables, and lamps suggest that participants associated the Mars habitat with the comfort and familiarity of their own homes. By drawing parallels between the exhibit and their living spaces, participants demonstrated an understanding of the importance in creating a sense of comfort and familiarity, even in unconventional settings. Discussions about plants, pets, and nature further emphasized the participants' desire to bring elements of nature and companionship into their living environments, mirroring their own preferences and needs in terrestrial households. By identifying with familiar household items and environments, participants seem to recognize the significance of these elements in promoting a sense of belonging, well-being, and normalcy. These relevance connections indicate the activity supports participants' understanding of the human desire for comfort, personalization, and a sense of home, regardless of the location or circumstances.

Personal Experiences

The activity also prompted discussions about hobbies and interests (28%), entertainment (18%), and the comforts of home (8%), fostering an understanding of how these elements contribute to their overall well-being. Moreover, the exploration of problem-solving skills and creativity (9%), collaboration (5%), and sustainability in the context of the Mars habitat (2%) highlighted their broader applications in everyday life. The connections participants made between the activity and their own experiences served to bridge the gap between the hypothetical scenario of living on Mars and the realities of their daily lives, making the activity more relatable and meaningful for visitors. 'Health and well-being', 'problem-solving and creativity', 'collaboration and teamwork', and 'sustainability and resource management' were mentioned to a lesser extent but still contributed to the overall discussion.

Participants were more confident in their ability to articulate principles of 'survive and thrive' after using the exhibit.

When reflecting on how they felt prior to participating, more than a third of participants indicated that they felt not at all confident identifying what humans would need to survive on Mars, and over 40% shared they only felt somewhat confident (Figure 25). Only 23% of respondents felt confident that they could identify what humans would need to survive (Figure 25). After participating, the majority of respondents (60%) felt confident or extremely confident they could identify what humans would need to survive on Mars, an increase of 60% since prior to using the exhibit (Figures 25 & 24).

Similarly, just under 40% of respondents felt 'not at all confident' they could identify what humans need to thrive and be happy on Mars prior to engaging with the exhibit; less than a quarter of

respondents felt confident in their ability to do so (Figure 26). After using the exhibit, about two thirds of respondents felt confident or extremely confident they could identify what humans needed to thrive and be happy on Mars; this is an increase amongst 60% of respondents (Figures 26 & 24). Respondents were also asked to reflect on their confidence in differentiating between surviving and thriving both before and after using the *Build a Human Habitat on Mars* exhibit. Prior to using the exhibit, more than a third of respondents were not at all confident in their ability to describe differences between survive and thrive, and nearly 40% were only somewhat confident (Figure 27). However, after using the exhibit only 7% of respondents still felt not at all confident; almost two-thirds of respondents felt confident or extremely confident in their ability to describe the differences between surviving and thriving on planets other than Earth (Figure 27).

Figure 24. Frequencies for changes in confidence to do the following after visiting the exhibit (n=126)

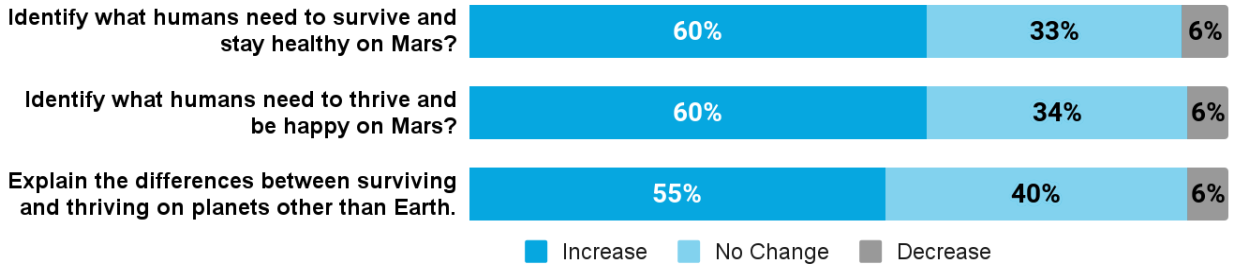


Figure 25. Before and after: How confident are you to identify what humans need to *survive* and stay healthy on Mars?

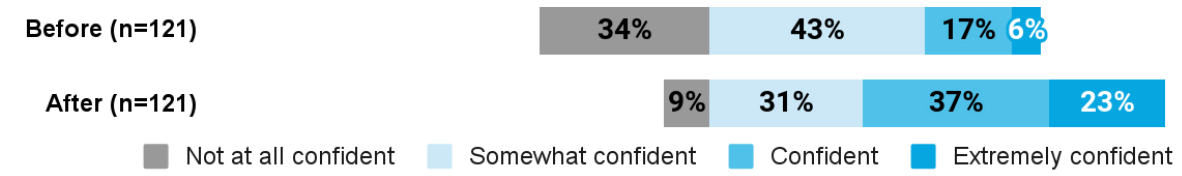


Figure 26. Before and after: How confident are you to identify what humans need to *thrive* and be happy on Mars?

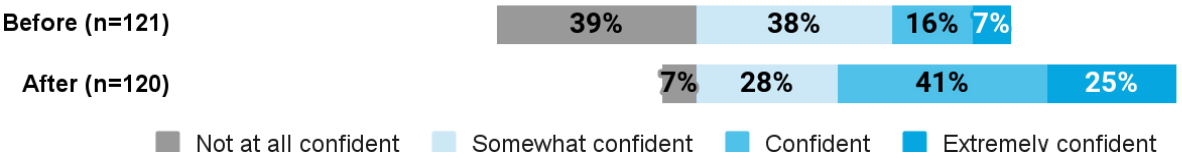
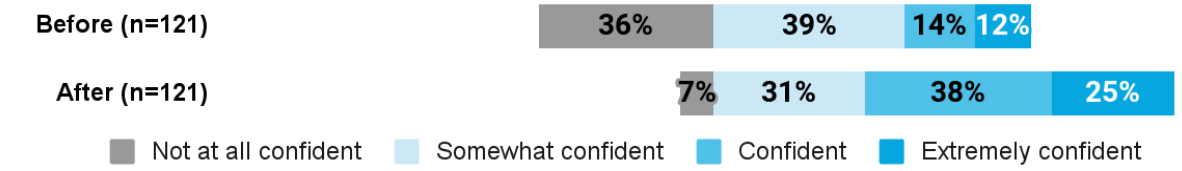


Figure 27. Before and after: How confident are you to explain the differences between surviving and thriving on planets other than Earth?

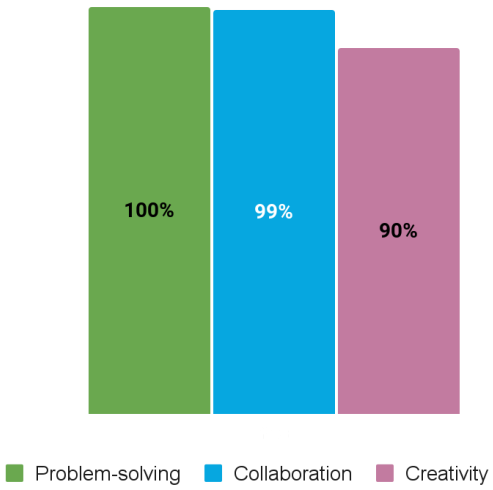


III. To what degree does the exhibit foster 21st Century Skills?

Participants were observed collaborating, problem-solving, and being creative more than once while using the *Build a Human Habitat on Mars* exhibit.

As mentioned earlier, observations specifically focused on exploring how the exhibit provided opportunities for visitors to utilize three 21st Century Skills: collaboration, creativity, and problem-solving. From observations, nearly every group was observed to demonstrate collaboration and creativity (Figure 28). All groups were observed to engage in problem-solving while using the *Build a Human Habitat on Mars* exhibit.

Figure 28. Percentage of groups observed engaging in behavior related to 21st Century Skills (n=68)

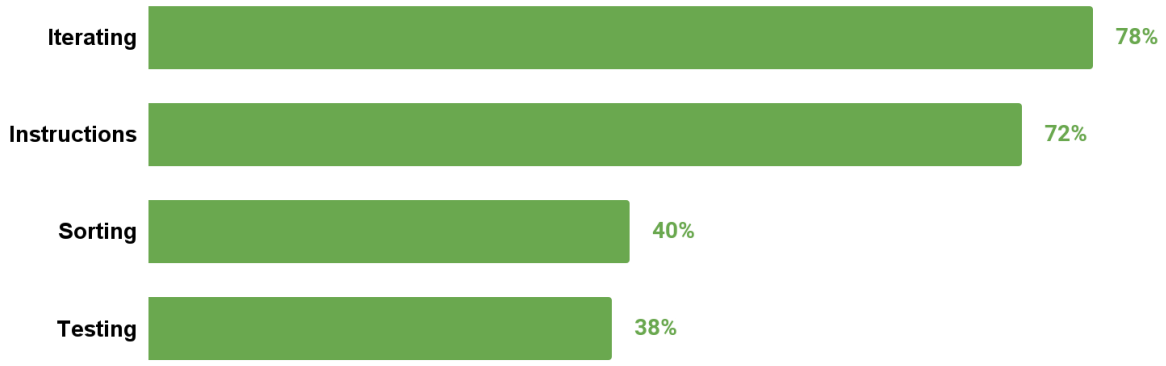


Overall, participants were most frequently observed 'iterating' (building something, testing it out, and then changing or refining the original build –among the "Problem-solving" behaviors in Figure 29.), 'imagining' (discussing possible scenarios or giving materials a different meaning or specifying use –among the "Creativity" behaviors in Figure 31), and 'scaffolding' (starting or continuing a conversation with the intent to support and guide building –among the "Collaboration" behaviors in Figure 30).

Observed Problem-solving

It is clear that the activity is extremely effective at supporting problem-solving skills. Amongst those observed problem-solving, iterating was the most frequently observed behavior across all SMM groups (78%), followed closely by groups' reliance on the 'instructions' that were part of the experience (returning to the main graphic signage and the challenge cards to consult and guide building decisions) (Figure 29). The icons on the blocks themselves also provided participants with information to make decisions in their builds. Sorting (categorizing pieces based on functionality or survive/thrive elements) and testing (a part of iterating, but confined to trying out how different blocks fit together) were also observed in a little more than a third of groups (40%, and 38%, respectively) (Figure 29).

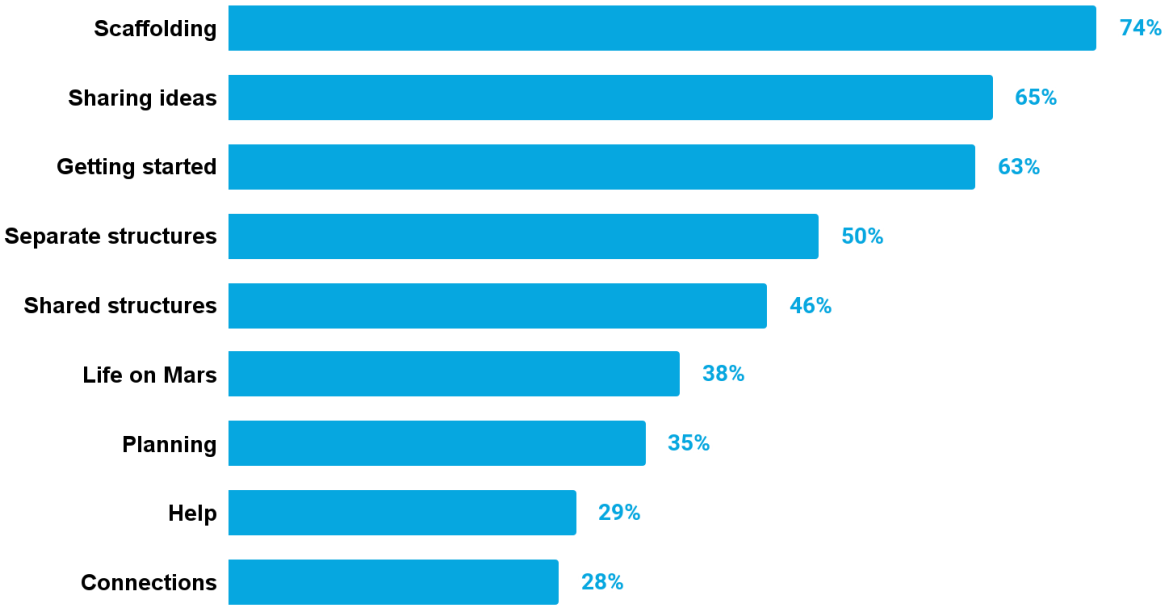
Figure 29. Problem-solving practices observed from participant group engagement in the exhibit (n=68)



Observed Collaboration

There was a larger list of observed behaviors that fell into the "Collaboration" skill category, and five of them were observed in at least half of groups (Figure 30). Nearly two thirds of the "Collaborative" behaviors observed were group members sharing ideas (65%) with each other, reading directions out loud to each other to understand how to get started with the activity (63%). We also observed that groups utilized collaborative skills regardless of if they were building a shared habitat (46%) or if they were building their own separate structures (50%). About a third of groups' collaborative behaviors included discussing content scenarios about life on Mars (38%) and making plans and decisions for their builds (35%). The collaborative behaviors observed least frequently were giving or receiving assistance (29%), and making connections to personal interests, hobbies, or daily life (28%). It is worth noting that it was often difficult to hear specifically what participants discussed with each other while they worked, so coded behaviors that relied on interpreting content of conversations (the last four codes in this section) may under-represent what was actually discussed.

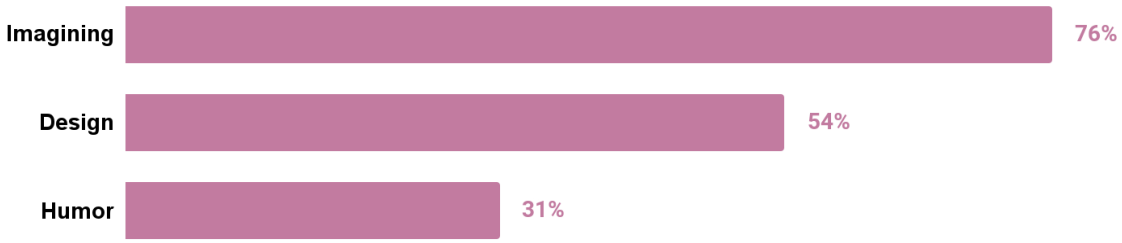
Figure 30. Collaboration practices observed from participant group engagement in the exhibit (n=68)



Observed Creativity

A handful of behaviors nested under the 21st Century Skill of "Creativity" were also observed (Figure 31), with imagining (making up scenarios and role-playing) being observed in just over three-fourths (76%) of groups. About half (54%) of groups also demonstrated creativity skills when they designed their habitats (intentionally dividing the structure into different rooms with intended purposes). Just under a third (31%) of groups added humorous and light-hearted elements to their discussions, designs, and interpretation of challenges.

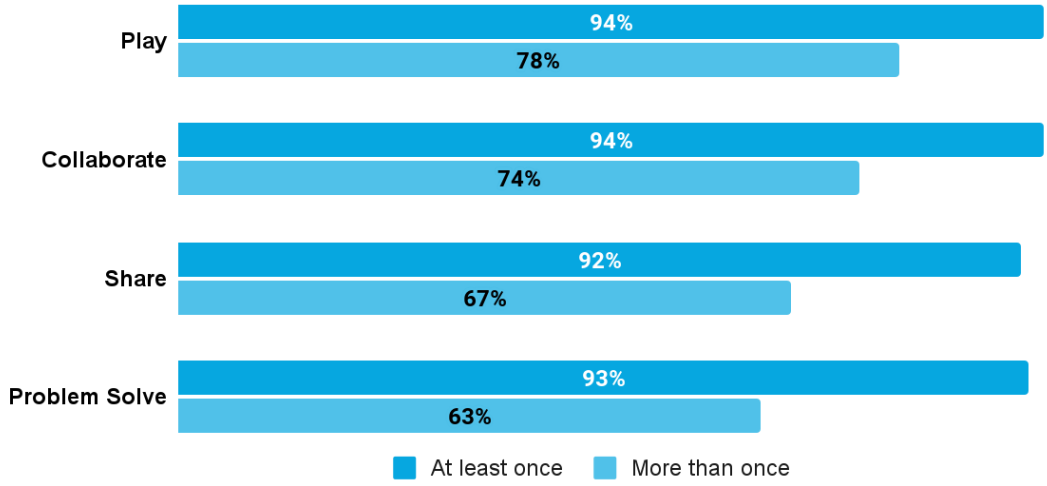
Figure 31. Creativity practices observed from participant group engagement in the exhibit (n=68)



Participants felt the exhibit provided opportunities to collaborate, solve problems, share ideas, and play together.

Observations from SMM align with participant self-reported survey data that the exhibit provided opportunities to practice 21st Century Skills. Around three-fourths (74%) of groups shared that they had the opportunity to collaborate more than once while using the exhibit, and two-thirds (62%) said they were able to share ideas with their groups more than once (Figure 32). About two-thirds (63%) of groups shared that they problem-solved more than once, and almost all groups (93%) problem-solved at least once during their time with the exhibit.

Figure 32. Distributions for "How much did your group do the following?" (n=126)



Survey respondents reflected on how confident they were in their ability to share how teamwork might be important to survival on Mars. Almost 60% of respondents indicated they were not at all confident, or somewhat confident, about how teamwork might be important on Mars ahead of using the exhibit (Figure 33). The majority of respondents (85%) shared that they felt confident or extremely confident in their ability to share how teamwork would be important after using the exhibit. Only 3% of respondents still felt not at all confident; across all respondents, almost two-thirds of respondents' confidence increased after using the exhibit (Figure 34).

Figure 33. Before and after: How confident are you to share at least one way that teamwork might be important to survive on Mars?

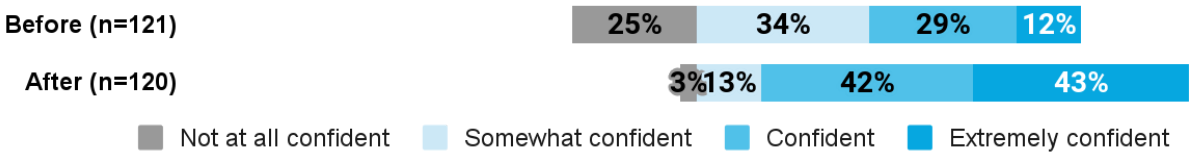
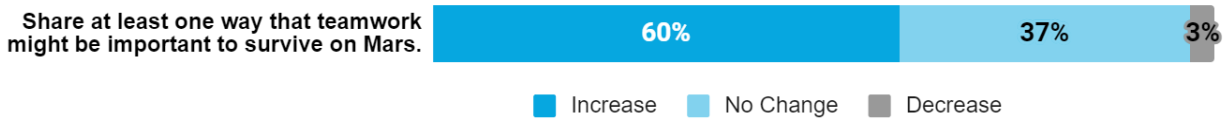


Figure 34. Frequency for change in confidence to share how teamwork might be important following the exhibit (n=126)



Participants identified how the exhibit connected to 21st century skills in their daily life.

Participants reflected on how the exhibit connected to their daily life, and while the majority of respondents described fact-based learnings and connections to "survive and thrive" (see pages 22-23), a small number of groups gave responses highlighting some of the 21st Century Skills the exhibit was intended to support.

Problem-solving

Participant learning reflected problem-solving among the groups who described an understanding of the challenges and complexities associated with living on Mars, including the need for resource management, adapting to the environment, and overcoming technological limitations. There were also instances of participants describing creativity skills when they offered innovative ideas and perspectives they took during the experience when reflecting on learning and connections –such as proposing new methods for addressing specific issues on Mars or suggesting novel approaches to survive and thrive in the harsh Martian environment.

Collaboration & Teamwork

Collaborative skills were also occasionally reflected in learning take-aways. Those comments emphasized the importance of teamwork in tackling the unique demands of Mars exploration, highlighting the necessity of cooperation and coordination. These respondents also indicated that the collaboration and teamwork skills they had to apply were among the ways the activity connected to their daily lives.

Also related to the concepts of collaboration and teamwork, some respondents remarked that as they explored the challenge cards and discussed the necessities for living on Mars, they realized the significance of companionship and the need for social interaction. They remarked that having pets or companions would help combat the potential loneliness of living in an isolated environment. This understanding was exemplified by one visitor who mentioned the importance of having someone to share the experience with and expressed that it would prevent them from "dying of loneliness."

Conclusion

The *Build a Human Habitat on Mars* exhibit provides visitors with an educational, enjoyable, and interesting experience that generates an increased understanding of 'survive and thrive' concepts as well as increased interest in the human exploration of space. Visitors found ways to connect the material to their everyday lives and reflect on how they would prepare to live on Mars. The *Build a Human Habitat on Mars* exhibit allowed visitors to engage collaboratively and creatively, and solve problems both on an individual and group levels. Visitors engaged in a wide variety of behaviors while at the exhibit demonstrating the experiences' ability to provide groups with multiple paths of engagement.

Appendices

Appendix A: Qualitative Codebooks

Observation codebook

Observed Behavior Codes within the context of 21st Century Skills

Collaboration/Communication: All these codes are applied with a lens that they are two or more people interacting.

- **Scaffolding:** Start or continue a conversation to guide the building
    - Back Board: Adult reads text or refers to large graphic signage text out loud in order to help guide children in completing the activity, or for their own understanding of the task.
    - Challenge cards: Adult reads text and refers to the challenge cards to help guide children in completing the activity or for their own understanding of the challenge.
- **Help**: Child asks adult for help with building or seeks their input on how or what they should build.
- **Life on Mars**: Converse specifically about Mars and what you need to survive/thrive in that environment. Discussing and making decisions on current needs, such as structural, space, or survive/thrive pieces to add.
- **Sharing ideas**
    - Sharing ideas about realistic or fantasy scenarios of what would happen for someone (either themselves or others) living in the structure or imagined events.
- **Planning:**
    - Brainstorming where to place survive/thrive building blocks within the structure(s). Sharing out their plans for where to place certain survive/thrive blocks, what they are building, or what they want to build.
    - Division of labor: Dividing tasks, such as finding certain blocks or building certain structures for group goals.
- **Getting Started:**
    - Discussing directions: Discussing directions or the activity together so that they have a shared understanding of the task at hand.
    - Discussing understanding: Two or more members talk through confusion of the task and sometimes help each other come to a shared understanding.
    - Naming: Share out loud the survive/thrive piece that they are adding or picking up.
    - Sorting: Collaboratively organize blocks into like piles (i.e., survive vs thrive, by intended room, etc.) or by creating rooms inside of structure with specific purposes and placing survive/thrive blocks that align with that purpose (i.e., toilets and shower go in bathroom).
    - Comparing: Group member(s) will use other group member's structures as a guide on what to add/remove to their own structure. Can be verbal or non-verbal (i.e., looking back and forth).
    - Collaborative exploration: Two or more group members collaboratively identify what each block means either by making a guess based on the picture, or pointing them out on the large graphic signage or challenge cards.
- **Connections**: making connections to personal interests, hobbies, or daily life.
- **Separate structures:**
    - Build independent- shared ideas: Build separate structures, but either follow or add similar features to other group members' structures.

    - Build independent-support: Build structures independently, but ask for help locating things when needed.
- **Shared structure(s):**
    - Build together-multiple: Two or more people work together on building multiple structures, giving each other input throughout.
    - Build together-single: The entire group works together to build a single structure.
    - Build independent-connect: Start out building separate structures independently, but then decide to connect their structure in some way (e.g., add a tunnel with connector blocks).

Problem-solving: These codes may be applied to behaviors of individuals or groups

- **Instructions:** returning to directions/instructions
    - Challenge cards: Consult challenge cards throughout to guide building and decisions.
    - Large graphic signage: Consult instruction signage throughout to guide building and decisions.
    - Examine blocks: Group member(s) individually examined blocks to get better understanding of what was on it.
- **Sorting**: Sorting/categorizing pieces based on functionality or survive/thrive elements. Picking up blocks and digging through the bin to identify different kinds of blocks and find what they need.
- **Iterating**: Tested out different placements and arrangements of the blocks within and outside of structure, including re-arranging order, to account for space limits or making decisions about which survive/thrive blocks they wanted. Might be in trying to meet initial goals and outcomes OR just adjusting to.
- **Testing**: Testing out how different materials and blocks fit together.

Creativity: These codes may be applied to behaviors of individuals or groups.

- **Humor:** Adding humor or a light-hearted element to the activity
- **Imagining**
    - Scenarios**:** Imagining how one might live in the space (either themselves or others)
    - Role Playing: Imaging self or others as famous people/scientists
    - Materials: Imagining different functionalities for materials other than intended purpose.
- **Design**: Intentionally divide structure into rooms with intended purposes (e.g., food area, activity area, bedroom, etc.)

Interview response codebooks

What are 1 or 2 things that you or your group learned about?

Facts and Knowledge

- **Importance of Resources**
  - Why we need communication systems
  - Oxygen scarcity on Mars
  - Why we need food and waste recycling
  - Greater need for power and water on Mars
- **Design and Layout Considerations**
  - Learning about layout and room organization
  - Considering the placement of different elements for survival
  - Understanding the need for specific areas (lab, growing area, etc.)
  - Considering the distribution and spread of resources
  - Thinking about the layout of survive and thrive elements
- **Understanding of Survive and Thrive**
  - Exploring the requirements and constraints of living in a non-habitable environment.
  - Awareness of the amount of resources needed to live on Mars
  - Understanding the necessity of various items for survival
  - Recognition of basic necessities (oxygen, water, food, etc.)
  - Understanding the difference between luxuries and necessities
  - Learning about the importance of a perfect habitat setup
- **Challenges and Limitations**
  - Recognition of the difficulties of living on Mars
  - Importance of training and preparation
  - Consideration of the limitations and constraints of Mars
  - Understanding the need for constant maintenance and resource management
  - Awareness of the constraints of available resources
- **Personal Perspectives and Preferences**
  - Learning about personal preferences and priorities
  - Realization of individual values and needs in a Mars habitat
  - Consideration of personal choices and lifestyle on Mars
- **Mars and Space**
  - Learning about the Mars environment
  - Understanding the time and distance involved in Mars exploration
  - Introduction to planetary exploration basics
  - Learning about different materials available on Mars, and their value
- Other
  - Curiosity about the internet and communication on Mars
  - Electricity is dangerous

21st Century Skills

- **Problem-solving**
  - Analyzing the requirements for survival on Mars and making informed decisions.
  - Considering the layout and organization of elements in the habitat.
  - Evaluating the importance of resources and their distribution.

    - Identifying potential challenges and limitations of living on Mars.
    - Applying creative thinking to overcome constraints and find solutions.
    - Adapting design choices based on available resources and constraints.
- **Collaboration**
    - Working together to build the habitat and discuss placement choices.
    - Sharing ideas and considering different perspectives on Mars living.
    - Collaborating to ensure even distribution of resources and optimal design.
    - Recognizing the importance of teamwork in surviving and thriving on Mars.
- **Creativity**
    - Coming up with unique designs or structures.
    - Applying artistic skills or different art styles to enhance the habitat model.
    - Using unconventional methods or strategies to address challenges or solve problems related to survival on Mars.
    - Making unexpected connections between the exhibit and other aspects of their daily life or personal interests.
    - Demonstrating innovative thinking by incorporating elements or features that go beyond basic survival needs, such as adding entertainment options or personalized spaces.
    - Expressing imaginative ideas or envisioning future possibilities for living on Mars.

What in your daily life connects to something you saw in this exhibit?

Surviving and Thriving

- **Health and Well-being**
    - Discussions of good food, physical and mental health, and comfort.
    - Participants recognized the **importance of taking care of themselves and maintaining their well-being** in daily life.
- **Essential Needs**
    - Recognizing the need for essentials like **food, water, oxygen, and shelter** in both the exhibit and their daily lives.
    - Reflecting an understanding of the basic requirements for sustaining life, both on Earth and in a Mars habitat.
- **Sustainability & Resource management**
    - Considering the **impact on the environment, resource conservation, and sustainable practices, such as recycling and energy efficiency**.
    - Understanding the importance of **managing and utilizing resources effectively, such as energy, power, and materials**.
- **Comfort**
    - Families mention the **importance of comfort in a Martian habitat**, such as having a comfortable bed, couch, or furniture.
    - Some participants highlight the need for comfort in terms of **physical well-being and mental health.**
    - The concept of comfort is often associated with familiar elements from daily life, such as having a favorite food or creating a cozy living space.
    - Comfort is also linked to the idea of creature comforts, including entertainment options, hygiene, and relaxation.
- **Home and Everyday Life**
    - Connecting the Mars habitat or resources to their daily lives at home.

    - Mention similarities to their living room, the big bed in their parents' room, and the presence of pets.
    - The **significance of familiarity and a sense of home in their daily connections.**
- **Entertainment**
    - Identifying **elements related to leisure, entertainment, and personal preferences, such as TV, video games, music, and favorite foods**.
    - References to video games, TV shows, music, playing outside, and other forms of entertainment suggest that individuals value activities that provide enjoyment and leisure.

Personal Experiences

- Hobbies and interests
    - Relating aspects of the exhibit to their own lives, hobbies, interests, or personal connections, such as pets, artwork, favorite foods, or favorite activities.
- Prior knowledge
    - Drawing connections to **prior knowledge, classroom learning, and previous exposure to topics** related to Mars, space, and science.

21st Century Skills

- **Problem-solving and Creativity**
    - Highlighting the importance of **problem-solving, strategic thinking, and creativity** in designing and building the exhibit.
- **Collaboration and team**work
    - Describing the value of **working together, communication, and collaboration** to **achieve common goals** that are part of the building activity.

Appendix B: Instruments

Mars Summative Observation Form

Mars Exhibit Observation DC: ____ Date: _____ #: _____

1) **Time of Day:** open-12 12-5 after 5
2) **Enter time (h/m): ____:_____ Leave time (h/m): ____:____ Duration (m/s): _____**
3) **Group size: # of youth ages 8 & under: # of adults (ages 18+):**
   # of youth ages 9-14:
   # of youth ages 15+:

21st Century Skills: Does the table support creativity, problem-solving, collaboration, and communication via the following behaviors?

	Behavior:	**Description:** Who does it? What does it look like? How frequently?
⬜	**Hands-on learning**	
⬜	**Look at something closely**	
⬜	**Play/imagine**	
⬜	**Building**	
⬜	**Testing**	

⬜	**Problem solving**	
⬜	**Sharing with others**	

General narrative descriptions:

- *What does visitor engagement look like with regards to activity <u>enjoyment and interest</u>?*
- *How are groups talking about SURVIVE and THRIVE?*
- *Are they using the challenge cards? How many? In what ways?*

Follow up Questions

3) Did you or your group learn anything new at the exhibit?

Yes No Unsure

3b) If yes, what are 1 or 2 things that you or your group learned about?

5) What in your daily life connects to something you saw in this exhibit?

Definitions of more abstract concepts or behaviors that could be ambiguous

Look at something closely	Reading supplemental information, examining challenge cards closely, revisiting instructions on the tombstone panel, revisiting block descriptions on the tombstone panel
Play/imagine	On or off topic exploration with the blocks and resources, 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.

Sharing with others	This is about sharing ideas and thoughts, not blocks/resources. For example, someone says “ah!” or “look at this!” to someone in their group. If they share an example of what they noticed or learned, this counts. It can be any other person at the table.
Testing	Trying out different building styles. Iterating rebuilding. Taking structures apart and rebuilding them.

Build a Human Habitat on Mars Survey DC: __ Date: _____ #: _____

Thank you for being in our study about the 'Build a Human Habitat on Mars' exhibit!

Your response helps us understand how this exhibit works for people. This survey is anonymous and voluntary, meaning you can stop at any time. While we may use this information in additional studies or share it with other researchers, we will not be able to link any individual responses back to you.

1) How interesting was the exhibit?

○ Not interesting ○ A little interesting ○ Interesting ○ Very interesting

2) How enjoyable was the exhibit?

○ Not enjoyable ○ A little enjoyable ○ Enjoyable ○ Very enjoyable

3) Did you or your group learn anything new at the exhibit?

○ Yes ○ No ○ Unsure

3b) If yes, what are 1 or 2 things that you or your group learned about?

4) How much has your interest in learning about space exploration increased after visiting this exhibit?

○ Not at all ○ A little ○ Somewhat ○ A lot

5) What in your daily life connects to something you saw in this exhibit?

For these next questions, we want to hear about your own experiences after using the Mars Habitat experience.

6) How confident do <u>you</u> feel in <u>your</u> ability to…?

Opportunity	Level of Confidence			
Identify what humans need to *survive* and stay healthy on Mars?	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Identify what humans need to *thrive* and be happy on Mars?	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Explain the differences between surviving and thriving on planets other than Earth.	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Share at least one way that teamwork might be important to survive on Mars.	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**

<u>7) BEFORE</u> visiting the Mars Habitat exhibit, how confident would you have felt to…

Opportunity	Level of Confidence			
Identify what humans need to *survive* and stay healthy on Mars?	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Identify what humans need to *thrive* and be happy on Mars?	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Explain the differences between surviving and thriving on planets other than Earth.	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**

Share at least one way that teamwork might be important to survive on Mars.	Not at all confident	Somewhat confident	Confident	Extremely confident

8) At the exhibit, how much did you or your group get to do each of the following?

	Not at all	At least once	More than once	I'm not sure
Play and use imagination.	☐	☐	☐	☐
Build something.	☐	☐	☐	☐
Solve a problem.	☐	☐	☐	☐
Work together.	☐	☐	☐	☐
Share an idea.	☐	☐	☐	☐

We want to know more about who we are hearing from to better understand how the exhibit is serving multiple audiences.

1) What is your age? _____

2) What is your gender identity?

☐ Man
☐ Woman
☐ Non-binary
☐ Prefer not to say
☐ Prefer to self describe: _____

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

☐ American Indian or Alaskan Native
☐ Asian or Asian American
☐ Black or African American
☐ Hispanic or Latino/a/x
☐ Native Hawaiian or Pacific Islander
☐ White
☐ Prefer not to say
☐ Prefer to self describe:_____

4) What are the ages and gender identities of the other people in your group today?

	person 1	person 2	person 3	person 4	person 5	person 6	person 7	person 8	person 9	person 10
Age										
Gender										

Thank you!

This material is based upon work supported by NASA under cooperative agreement award numbers 80NSSC20M0030. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the view of the National Aeronautics and Space Administration (NASA).

Build a Human Habitat on Mars Survey (Spanish)

Encuesta de exhibición de Marte DC: _____ Fecha: _____ #: _____

¡Gracias por estar en nuestro estudio!

Su respuesta nos ayuda a comprender cómo funciona esta exhibición para las personas. Esta encuesta es anónima y voluntaria, lo que significa que usted puede detenerse en cualquier momento. Si bien podemos usar esta información en estudios adicionales o compartirla con otros investigadores, no podremos vincular ninguna respuesta individual con usted.

1) ¿Qué tan <u>interesante</u> fue la exposición?

No fue interesante ○ un poco interesante ○ Interesante ○ Muy interesante

2) ¿Qué tan <u>agradable</u> fue la exhibición?

No fue agradable ○ Un poco agradable ○ Agradable ○ Muy agradable

3) ¿Usted o su grupo aprendieron algo nuevo en la exhibición?

Si ○ No ○ No estoy seguro

3b) En caso afirmativo, ¿cuáles son 1 o 2 cosas que usted o su grupo aprendieron?

4) ¿Cuánto ha aumentado su interés por aprender sobre exploración espacial después de visitar esta exhibición?

○ En nada ○ Un poco ○ Algo ○ Mucho

5) ¿Qué en su vida diaria se conecta con algo que vio en esta exhibición?

Para las siguientes preguntas, queremos escuchar sus propias experiencias después de usar la exhibición de Mars Habitat.

6) ¿Qué tan seguro se siente <u>usted</u> de <u>su</u> capacidad para…?

Oportunidad	Nivel de confianza			
¿Identificar lo que los humanos necesitan para sobrevivir y mantenerse saludables en Marte?	**Nada seguro**	**Algo seguro**	**Seguro**	**Extremadamente seguro**
¿Identificar lo que los humanos necesitan para prosperar y ser felices en Marte?	**Nada seguro**	**Algo seguro**	**Seguro**	**Extremadamente seguro**
Explicar las diferencias entre sobrevivir y prosperar en planetas que no sean la Tierra.	**Nada seguro**	**Algo seguro**	**Seguro**	**Extremadamente seguro**
Compartir al menos una forma en que el trabajo en equipo podría ser importante para sobrevivir en Marte.	**Nada seguro**	**Algo seguro**	**Seguro**	**Extremadamente seguro**

7) ANTES de visitar la exposición Hábitat de Marte, ¿qué tan seguro se hubiera sentido de ...

Oportunidad	Nivel de confianza			
¿Identificar lo que los humanos necesitan para *sobrevivir* y mantenerse saludables en Marte?	**Nada seguro**	**Algo seguro**	**Seguro**	**Extremadamente seguro**
¿Identificar lo que los humanos necesitan para *prosperar* y ser felices en Marte?	**Nada seguro**	**Algo seguro**	**Seguro**	**Extremadamente seguro**
Explicar las diferencias entre sobrevivir y prosperar en planetas que no sean la Tierra.	**Nada seguro**	**Algo seguro**	**Seguro**	**Extremadamente seguro**
Comparta al menos una forma en que el trabajo en equipo podría ser importante para sobrevivir en Marte.	**Nada seguro**	**Algo seguro**	**Seguro**	**Extremadamente seguro**

8) En la exhibición, ¿cuánto pudieron hacer usted o su grupo en cada uno de los siguientes?

	Nada	Al menos una vez	Mas de una vez	No estoy seguro
Jugar y usar la imaginación.	☐	☐	☐	☐
Construir algo.	☐	☐	☐	☐
Resolver un problema.	☐	☐	☐	☐
Trabajar juntos.	☐	☐	☐	☐
Compartir una idea.	☐	☐	☐	☐

Queremos saber más sobre de quién estamos escuchando para comprender mejor cómo la exhibición está sirviendo a múltiples audiencias.

1) ¿Cuál es su edad? _____

2) ¿Cuál es su identidad de género?

☐ Hombre
☐ Mujer
☐ No binario
☐ Prefiero no decir
☐ Prefiero autodescribirme: _____

3) ¿Con qué grupo(s) racial o étnico(s) se identifica? (Marque todo lo que corresponda.)

☐ Indio americano o nativo de Alaska
☐ Asiático o asiático americano
☐ Negro o afroamericano
☐ Hispano o latino/a/x
☐ Nativo hawaiano o isleño del Pacífico
☐ Blanco
☐ Prefiero no decir
☐ Prefiero describirme:_____

4) ¿Cuáles son las edades e identidades de género de las otras personas en su grupo hoy?

	persona 1	**personas 2**	**personas 3**	**personas 4**	**personas 5**	**personas 6**	**personas 7**	**personas 8**	**personas 9**	**personas 10**
Edad										
Género										

¡Gracias!

Este material se basa en el trabajo respaldado por la NASA bajo los números de adjudicación del acuerdo cooperativo 80NSSC20M0030. Todas las opiniones, hallazgos y conclusiones o recomendaciones expresadas en este material pertenecen al autor(es) y no reflejan necesariamente el punto de vista de la Administración Nacional de Aeronáutica y del Espacio (NASA).

Appendix C: Remote Collection Tools

Recruitment Sign at Continental US Remote Sites:

Recruitment Sign at Puerto Rico Remote Site:

Mars Habitat Summative Survey Data Collection FAQ:

General Questions

Who is running this study?

This study is being managed by the evaluation department at the Science Museum of Minnesota in St. Paul. Gretchen Haupt and Elena Tsakakis are the evaluators for the project. They can be reached at ghaupt@smm.org and etsakakis@smm.org.

Who do I contact if I have questions about the study?

Please contact Gretchen Haupt (she/her), Research and Evaluation Associate at the Science Museum of Minnesota with all of your practical and theoretical questions.
Email: ghaupt@smm.org
Mobile: 314.583.5242

You can also reach out to the Heartland Institutional Review Board with ethical concerns about the study at (866) 618-HIRB or director@heartlandirb.org.

What is this study trying to uncover?

This study is trying to find out if visitor experiences match the exhibit's intended outcomes and for reporting to the funder (NASA).

Who will see my survey answers?

Only research and evaluation staff at the Science Museum of Minnesota will see your survey responses. A summary of visitor responses will be shared with the Exhibit development team at the Science Museum of Minnesota and the funding agency (NASA). The final report will also be shared on informalscience.org. There will be no identifying information included in the reports.

Questions about the survey

Who can take the survey?

We can only collect surveys from adults (18 years old and up) who have used the *Build a Human Habitat on Mars* exhibit. We are most interested in hearing from groups with children in 4th through 8th grade who use the exhibit together, but the only requirement to complete the survey is being 18 or older.

How long is the survey?

It takes most people about 5 minutes to complete the survey, but some choose to give more detailed answers.

How do I take the survey?

You can use your phone's camera to scan the QR code on the recruitment signs near the exhibit. Depending on your phone, it will either immediately open a web browser on the first page of the survey, or it will prompt you to open the browser.

You can also type the URL address on the recruitment sign directly into a browser on a mobile device or your home computer. It will redirect you to the first page of the survey, which is hosted by the online survey platform Alchemer.

Is the survey available in languages other than English?
Yes, the survey is available in all of the languages included on the recruiting sign (depending on your site (English and Spanish.) Use the QR code or the URL to access the first page of the survey where you will be able to select which language you would like to use to complete the survey.

Can I take the survey after I leave?
The survey is brief, and we recommend completing it before you leave the area, but you may also complete the survey later, especially if you prefer not to use a mobile device.

Incentive Questions
What is the thank you?
You will have an opportunity to register for a $10 VISA gift card after you complete the survey as a thank you for your time and participation.

How will I get my $10?
After you reach the last page of the survey, you will be linked to a new form to enter email contact and address information so that someone at the Science Museum of Minnesota can place an order for a third party (Perfect Giftcard) to send you a $10 VISA gift card directly to your preferred address. This form is separate from your survey answers so they can remain anonymous.

How long will it take to get my gift card?
After processing, it takes between 2-5 weeks for your gift card to arrive. Someone from the Science Museum of Minnesota will contact you by email to let you know the order has been processed.

Appendix D: Additional Figures and Analyses

The majority of groups shared facilitation responsibilities (63%), while in about a third of groups kids were the primary drivers of the activity (Figure 1). Nearly three quarters of observed groups referred to the instructions to guide their experience, and just under half of groups utilized the optional 'Challenge Cards' provided for those interested in a more guided building experience (Figures 2 & 3).

Figure 1. Observed facilitation responsibility at the Build a Human Habitat on Mars exhibit (n=68)

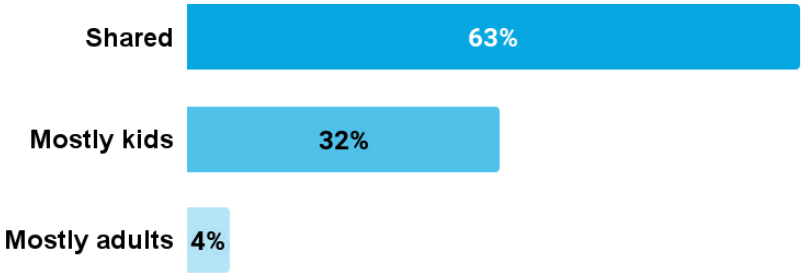


Figure 2. Referred to Instruction Graphic Signage: Distribution of Observed Groups (n=68)

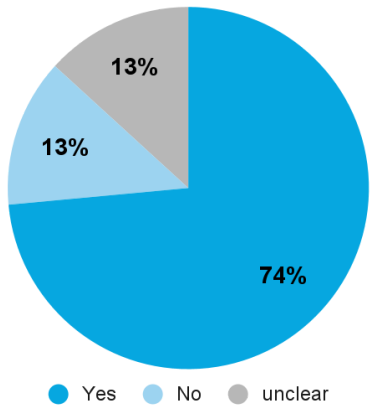


Figure 3. Utilized Challenge Cards: Distribution of Observed Groups (n=68)