



EXPLORE SCIENCE

Voyage through the Solar System

Voyage through the Solar System

Summative Evaluation

September 2024

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Background and Introduction

The “Voyage Through the Solar System” products were designed to engage public audiences with authentic STEM learning opportunities that leverage NASA content through the development and dissemination of a toolkit of inquiry-based, hands-on activities, as well as a new DIY app to extend experiences beyond museum settings. The project aims to inspire the next generation of explorers and provide access to high-quality STEM education resources.

Project Outcomes

The project aims to achieve three key outcomes:

1. Improved attitudes toward STEM.
2. Increased knowledge and understanding of space exploration, science, and engineering.
3. Increased STEM at-home engagement.

This summative report specifically addresses the first two outcomes.

Organization of Findings

The findings of this report are organized into three main sections:

1. Museum-Based Activities
2. DIY App Activity
3. A brief comparison between the two products.

The first two sections are further divided to address the following three main evaluation questions:

1. **Interest, Awareness, and Knowledge:** In what ways do activities increase the public’s interest, awareness, and knowledge about space exploration, science, and engineering?
2. **Engagement:** Are activities engaging for public audiences?
3. **Influence on Attitudes:** In what ways does the project influence participants’ attitudes about human exploration and NASA missions?

Executive Summary

Both products developed for the “Voyage Through the Solar System Project” were found to successfully enhance public interest, awareness, and knowledge about space exploration, science, and engineering. Both formats were highly engaging, though they exhibited distinct strengths related to their format and design.

Museum-Based Activities

Participants across all age groups found the museum-based activities highly enjoyable and engaging. The interactive nature of tasks, such as building a moon base and selecting which items to include, spurred creativity and engagement within and across groups. These activities effectively connected scientific concepts to daily life, making them relatable through elements like pets, favorite foods, and music. Conversations often tied scientific principles to personal experiences, enhancing understanding and introducing new information.

Participants' interest in human space exploration and NASA missions increased significantly. Nearly all groups reported intentions to continue learning about ideas and concepts they experienced using the activities, particularly among older children, who were eager to learn more about future space missions and historical context. The museum setting provided a conducive environment for immersive learning and sparked wonder about space exploration's broader implications.

DIY Solar System App

The DIY Solar System App also succeeded in increasing public interest and knowledge. Participants, especially younger children, reported learning basic space facts, while older children gained insights into human space missions and technology. Activities like "Space Garden," "Breath of Fresh Air," "Ice Orbs," and "Code a Mars Rover" were particularly effective in maintaining interest and fostering curiosity to learn more.

Although the digital and AR activities received mixed survey ratings, they were generally well-received, particularly by groups that included younger children. The app facilitated strong connections to human space exploration, with over half of the groups reporting increased interest in NASA's missions. Despite some lower ratings for some aspects of a handful of specific activities, the app positively influenced participants' attitudes towards space exploration.

Additionally, five follow up interviews with groups that used the DIY App in their homes provided additional perspectives and context for the survey ratings –most notably that interest in and knowledge of space and human space exploration was likely already high among the individuals recruited to give survey feedback. Interview participants also praised the app's user-friendly design and enthusiastically described the enjoyment they derived from completing the activities. The "In and Out" game was frequently mentioned as a highlight and nearly every group

referenced information they learned while playing it, and the Space Garden activity was frequently mentioned as something groups enjoyed doing and looked forward to coming back to check on. The augmented reality components, particularly Planet Walk, were praised for being an immersive experience. Beyond the visual novelty of seeing planetary bodies in unexpected settings, groups appreciated the opportunity to explore planetary surfaces and simulate space conditions in a way that is interactive and visually engaging.

One consistent gap noted among interview participants was that while the app was fun, some activities felt like one-time experiences with low replay value. This feedback suggests that users were interested in more varied and challenging content to maintain their engagement over time.

Comparison of Museum-Based Activities and DIY App Activities

- **Enjoyment and Interest:** Museum-based activities were rated more enjoyable and interesting. The museum environment and facilitation of activities may have contributed to higher ratings.
- **Learning:** Both formats reported similar learning outcomes. Museum activities emphasized human connections in space exploration, while the DIY app resulted in more reports of factual information.
- **Engagement with Content:** Content drove interest in both formats. The DIY app's format and design also played a significant role in participant engagement.
- **Connections to Human Space Exploration:** Both groups felt connected to space exploration, with museum-based participants reporting slightly stronger connections.
- **Interest in Learning More:** Museum activities led to a greater increase in interest in learning more about space exploration.
- **Changes in Attitudes:** Museum activities resulted in higher increases in positive attitudes towards space exploration.
- **Relevance and Connections to Daily Life:** Museum participants referenced human needs, while DIY app participants mentioned hobbies and personal interests, reflecting different content and context.
- **Curiosity and Wonderings:** Museum participants were more curious about future missions, while DIY app participants focused on past and present missions and technology.

Overall, museum-based activities excelled in fostering interest and positive attitudes towards space exploration, while the DIY Solar System App effectively delivered factual information and engaged through structured content.

Methodology

Multiple methods were used in this study, including uncued observations, surveys, and interviews.

Museum based activities

In the case of the museum based activities, evaluators visited the Bell Museum and the Bakken Museum in Minneapolis, MN where the three interactive kit activities were offered to visitors during events. The Bakken “STEM Studio” events occurred on Saturday mornings, and were primarily attended by family groups with young children. Data was collected at the Bell museum’s free “Star Party” events, which occurred in the evening and included additional space themed table top activities and information, and the multi-day paid special event “Space Fest.”

Evaluators approached families with children between the ages of 8 and 14 with the intention of observing their behaviors and conversation while engaging in the facilitated activities. Once groups finished their activities they were given the opportunity to take a survey about their experience with the activities with the incentive of museum based gifts. Groups were able to do one, two, or all three activities.

DIY App

A multi-phased approach was applied to the DIY App based activities. Evaluators recruited groups with children in the desired age range from Science Museum of Minnesota visitors and members (via email). All participants were mailed the materials for three designated activities (half received materials for “Breath of Fresh Air,” “Space Souvenir,” and “Pack Your Bags,” and half received materials for “Ice Orbs,” “Solar System Trek,” and “Space Garden) and instructed to download the DIY Solar System app for the instructions on their assigned activities. Participants were encouraged to try the games and digital activities within the app that did not require materials, and were told they could also try activities they did not receive materials for if they were interested. After two weeks, participants were emailed a survey about their experience with the app and the DIY activities, which included an opportunity to indicate interest in a follow up interview. Participants received a \$25 gift card for their time using the app and completing the survey, and an additional \$25 gift card for an interview.

Describing the Sample

Across both products, we collected observation, survey, and interview responses from 128 groups, all of which included at least one adult and one child. The only demographic information gathered from participants was age and gender of respondents and group participants (Table 1), but the analysis only considered age composition of children in the group as a variable. All interview respondents were drawn from the App Survey population.

Table 1: Participant Descriptives

	Museum-Based Activities (Observations and Surveys) 77 Groups	DIY App Activities (Surveys and Interviews) 51 Groups
Adult Respondents		
Women	51%	53%
Men	36%	18%
Non-binary	3%	0%
Unknown	10%	29%
Child Gender Composition		
Girls only	21%	20%
Boys only	35%	37%
Both girls and boys	26%	29%
Unknown	18%	14%
Child Age Composition		
Includes under 8 years old	48%	37%
Only 8 years and older	35%	49%
Unknown	17%	14%

Findings

Museum-Based Activities

There were three museum-based activities that were evaluated as part of the Voyage Through the Solar System kit: Breath of Fresh Air, Build a Moon Base, and Space Medallion.

Are activities engaging for public audiences?

Observation data indicates that the activities are highly enjoyable and engaging for participants. Children and adults alike find personal connections to the tasks, whether through drawing their favorite animals on medallions, discussing everyday experiences like brushing teeth and camping, or referencing popular culture such as movies and books. The interactive nature of the activities, like building a space base and selecting thrive items, sparks creativity and excitement. Participants eagerly share their ideas and preferences, debating the merits of various survival needs and comfort items in space, which showcases their active involvement and enjoyment.

Moreover, the activities encourage both educational and imaginative exploration. Children express fascination with scientific concepts, such as photosynthesis and air recirculation on the ISS, and relate them to their own experiences and knowledge. The inclusion of familiar elements, such as pets, favorite foods, and music, further enhances their engagement. Conversations are rich with references to personal hobbies, like Lego building and space-themed stories, indicating that the activities resonate deeply with their interests. Overall, the observation data clearly

demonstrates that the activities are not only informative but also fun and captivating, fostering a lively and enthusiastic learning environment.

All groups said they thought the activities as a collection were, to some extent, enjoyable (Fig. 1) and interesting (Fig. 2), and no one gave the lowest ratings of “Not at all.” Not all groups used all the activities, and we noticed that groups who experienced “Breath of Fresh Air” more frequently gave the highest ratings, with over half saying it was “Very” enjoyable/interesting, but overall there was not substantial variation in enjoyment and interest regardless of if groups used one, two, or all of the activities.

Fig 1: Overall, how enjoyable was the activity? (n=77)



Fig. 2: Overall, how interesting was the activity? (n=77)



Age Composition: Activities work well for all age group compositions, but best with 8-14 year olds

The museum-based activities worked well for groups with children of any age, but more groups gave the highest enjoyment (Fig. 3) and interest (Fig. 4) ratings when younger children were not present (i.e., groups that included only children 8 and older). Groups that did not include any children in the project’s target age gave the highest ratings of enjoyment and interest *less frequently* than groups that included at least one child between the ages of 8 and 14, but overall, ratings remain high regardless of age composition.

Fig 3: Overall, how enjoyable was the activity? By age composition of children

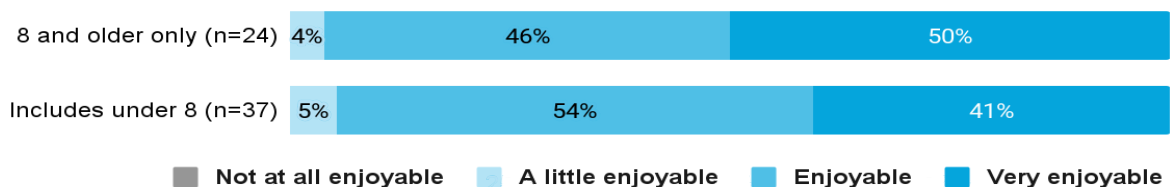
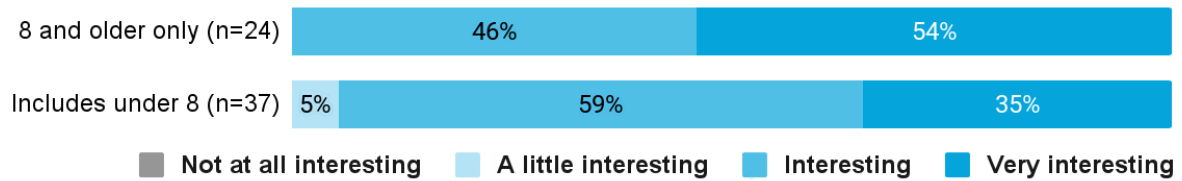


Fig. 4: Overall, how interesting was the activity? By age composition of children



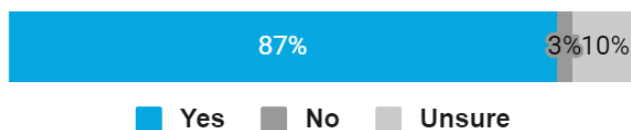
In what ways do activities increase the public’s interest, awareness, and knowledge about space exploration, science, and engineering?

Observations indicate that groups increased their interest, awareness, and knowledge about space exploration, science, and engineering. Conversations frequently revolved around scientific principles and real-world applications, such as discussions on the chemical reactions involved in photosynthesis, the use of CO₂ scrubbers, and the challenges of surviving in space. Participants engaged with space exploration concepts like air recirculation on the ISS, the need for water and hygiene in space, and the role of plants in converting CO₂ to oxygen. These discussions often included references to personal experiences and prior knowledge, demonstrating that the activities not only introduced new information but also reinforced existing understanding in a meaningful context.

Additionally, the data shows that participants were inspired to make connections between the activities and broader scientific and engineering concepts. Adults and children alike discussed historical and contemporary figures in space exploration, such as Elon Musk and the Artemis mission, and debated the logistics of space habitation, including the importance of hygiene, nutrition, and exercise. References to books, movies, and past scientific endeavors, like the Challenger explosion and biospheres, indicate a growing awareness and curiosity about space. This heightened interest was also reflected in their enthusiasm for designing space bases, choosing thrive items, and imagining future possibilities for human space exploration. Overall, the activities effectively heightened participants' engagement with and understanding of space-related science and engineering topics.

The majority of groups reported learning something new (Fig. 5) when they used the museum activities. We noticed that groups that experienced Breath of Fresh Air or Space Medallion, were more likely to report learning something.

Fig. 5: Did your group learn anything? (n=77)



Emergent coding of responses to the question "What are one or two things your group learned about?" were consistently germane to the topic of human space exploration and fell into two primary categories: "Basic Facts and Content Knowledge" and "Human Connections."

The "Basic Facts and Content Knowledge" category (light blue in Fig. 6, below) encompasses several sub-codes:

1. **Space and Planets** - Includes names, information, and details about celestial bodies, as well as information about radiation in space.
2. **Chemical Reactions/Chemistry** - Covers how substances like zeolite work and details about CO₂.
3. **Technology** - Encompasses knowledge about space suits, filtration systems, robotics coding, food storage, and food creation technologies.
4. **Human Space Exploration and Missions** - Involves specific missions, names of shuttles, the International Space Station (ISS), questions about future space exploration, living on different planets, and general concepts related to human space missions and exploration.

The "Human Connections" category (dark gray in Fig 6, below) focuses on the human aspect of space exploration and includes the following sub-codes:

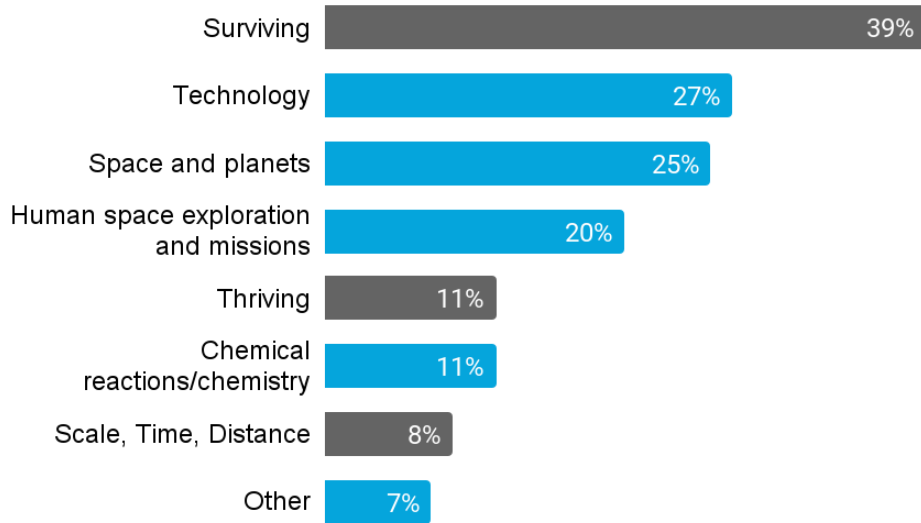
1. **Scale, Time, Distance** - Understanding and context based on human perspectives, such as the time it takes to travel somewhere in space, the vast distances involved, and the enormous sizes of celestial bodies.
2. **Thriving** - Ideas and concepts that go beyond basic survival, exploring how humans could thrive during space exploration.
3. **Surviving** - Covers the fundamental needs and concepts related to human survival in space or on long missions.

"Moon Base" was the only activity where groups mentioned learning ideas about thriving, or generally exploring concepts about what goes beyond basic survival during human space exploration. It was also the activity where the most respondents reported learning about those basic human survival needs, though that idea also came up frequently among the other two activities.

The Space Medallion activity seemed to generate the most learning about the scale involved in space travel, how long it takes to get between the massive distances, and facts about past missions.

Both Space Medallion and Breath of Fresh Air provided opportunities to learn facts about space and planets, as well as the technology that supports human space exploration (Like space suits on missions and the air filtration system on the ISS).

Fig. 6: “What are one or two things your group learned about?” (n=71)



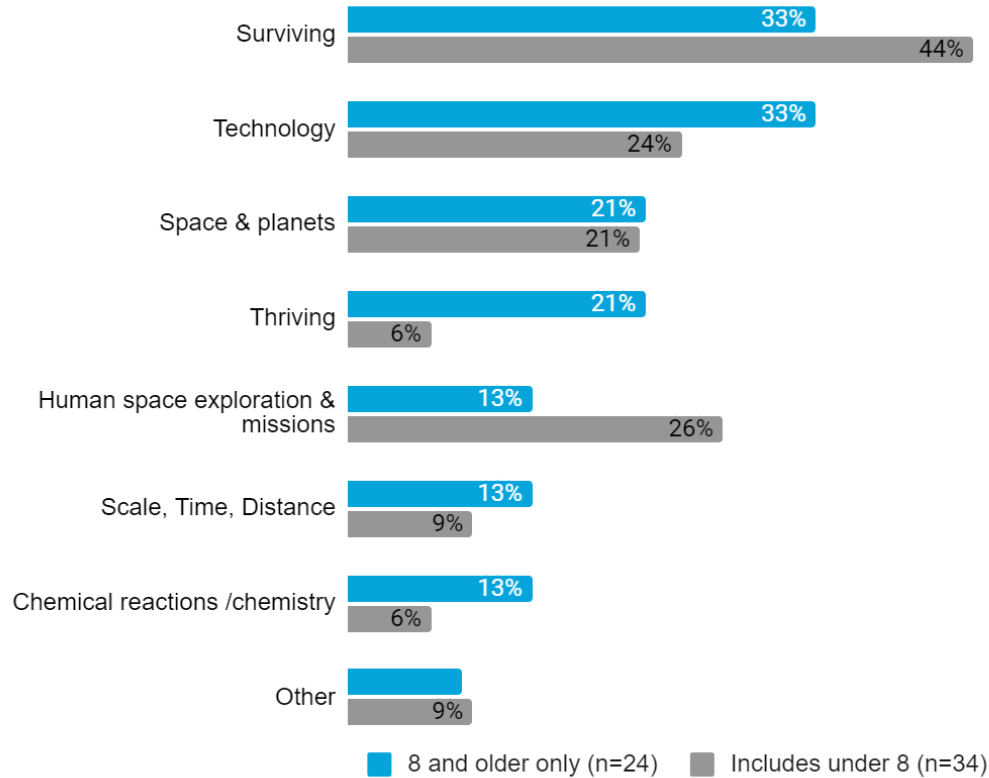
Age Composition

Age composition did not appear related to learning something in general (Fig. 7), but there were differences in what groups reported learning based on the age composition of children participating (Fig. 8). When younger children are absent, groups reported learning ideas about “Thriving,” the different types of technology employed in human space exploration, and chemistry or chemical reactions. In contrast, when younger children were included, groups more frequently reported learning facts about planets and space, what it takes for humans to survive space travel, and about specific human space missions.

Fig. 7: Did your group learn anything? Age composition

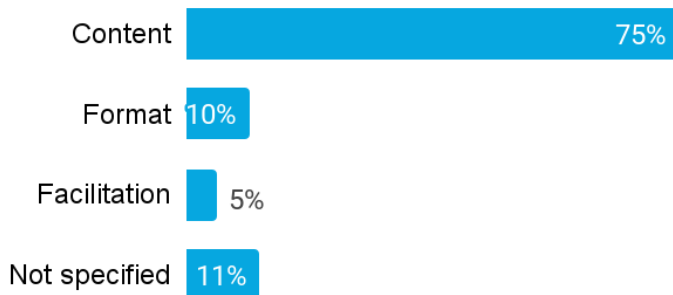


Fig. 8: “What are one or two things your group learned about?” (Age Composition)



Over two-thirds of respondents described information presented in the activity (coded as “content”) as what made them interested to learn more (Fig. 9) following their experiences with the activities. This is compared to reasons related to the way the activity was designed (Format) or the way they were guided through the experience by staff or another person in their group (Facilitation). This holds true across all three museum activities and groups’ age composition.

Fig. 9: What about the Activities made you want to learn more (n=63)?



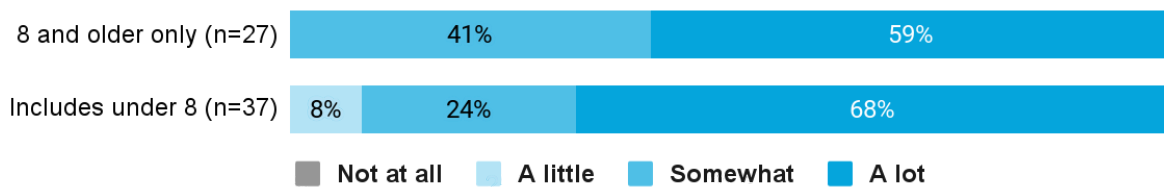
Respondents generally saw a high level of connection between the activities and human space exploration (Fig. 10). Nearly two thirds gave the highest rating of “A lot” and all groups said the activities connected at least “A little.” Groups who experienced The Moon Base and/or Space Medallion activities reported slightly stronger connections than Breath of Fresh Air. Connections came through fairly well for groups of all ages, and while those with younger children may have

seen the connection more strongly (a larger proportion gave the highest rating, “a lot”), the connection may be more consistent where groups are composed only of older children (Fig. 11) – that is all groups marked “somewhat” or “a lot.”

Fig. 10: How much did the activities connect to human space exploration? (n=77)



Fig. 11: How much did the activities connect to human space exploration? Age composition



Themes from Observations: Discussions of Human Space Exploration

Nearly all respondents reported that their interest in learning about human space exploration and NASA’s return to the moon increased at least “A little” (Fig. 12) and we noticed that interest being the strongest among groups that experienced the Space Medallion activity. This interest was also stronger among groups that included older children, as all respondents who said they had no increased interest were part of groups that included only children under 8 years of age (Fig. 13).

Fig. 12: How much has your interest in learning about human space exploration and NASA’s return to the moon increased? (n=77)

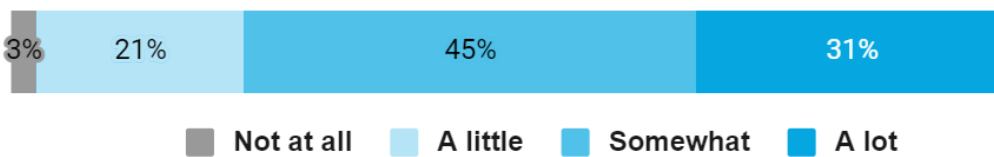
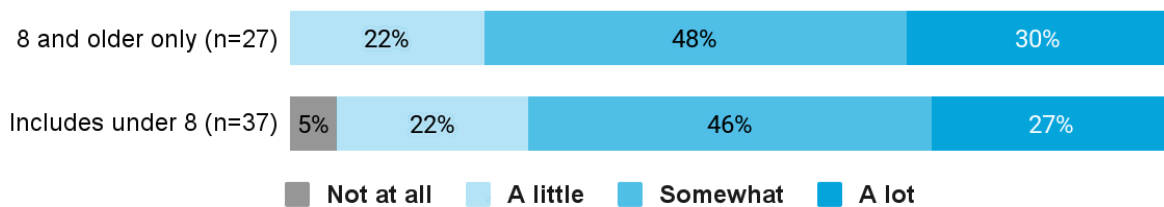


Fig. 13: How much has your interest in learning about human space exploration and NASA’s return to the moon increased? Age composition



About a third of respondents reported an increased¹ interest in space exploration (Fig. 14) and an increase in knowledge about space exploration (Fig. 15) after experiencing the activities. The changes in agreement for interest and knowledge are statistically significant, and there does not appear to be large differences in before and after ratings based on exposure to a specific activity (Figs 16 & 17).

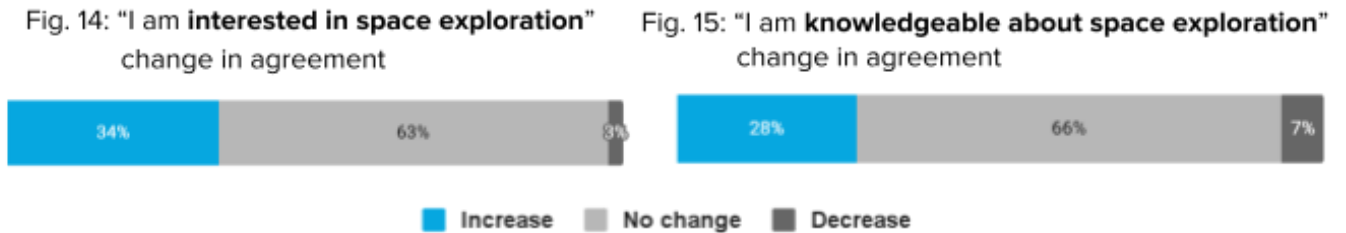


Fig. 16: Agreement/Disagreement with statement "I am interested in space exploration" BEFORE and AFTER the activities:

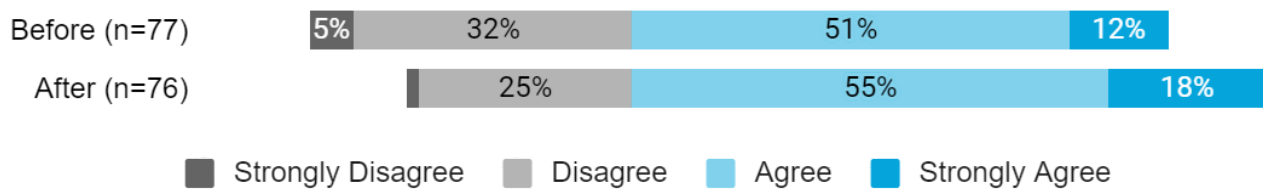
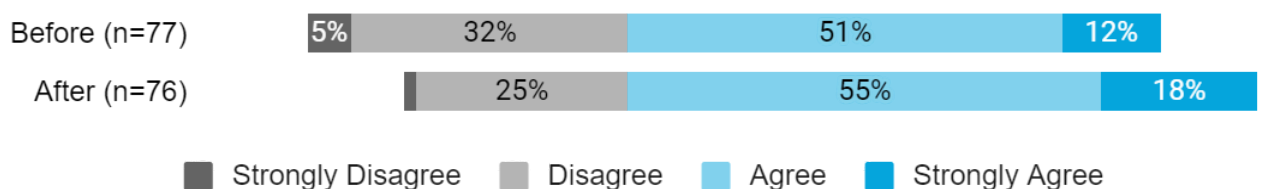


Fig. 17: Agreement/Disagreement with statement "I am knowledgeable about space exploration" BEFORE and AFTER the activities:



In order to get a better understanding of the ways the activities were inspiring interest in space exploration, we asked respondents what their groups were wondering about or wanted more information about. We started with the coding rubric for an earlier question about what groups learned, as "wondering" could also be understood as what they want to continue learning about. One category, "human space exploration missions" was split into two categories to capture

¹ Respondents were asked to rate their agreement with the statements "now" followed by reflecting on how they would have answered "before using the app" so each set of ratings was matched. The distribution of "increase/no change/decrease" was calculated based on any movement up or down the rating scale, so someone reporting they "Strongly disagreed" before and "disagreed" after would be noted as having "increased their agreement. Likewise someone who "Strongly agreed" with a statement before moving to "Agree" after would be coded as "decreased agreement."

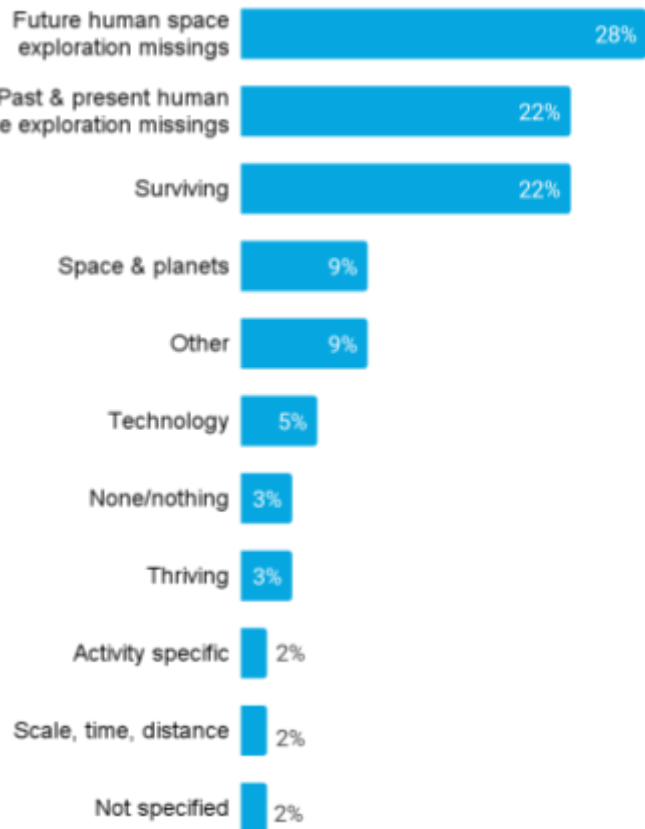
groups that were specifically wondering about what the future of human space exploration would entail, and those who were curious about the past and present human space exploration, and new category was added to describe groups who indicated they were wondering about things, but did not specify what those things were.

Based on the distributions in Fig. 18, groups who used the facilitated activities in museum settings seem primed to think about human space exploration after their experiences. They are wondering about what might be possible in the future as humans establish habitation and research stations on Mars and explore further, and they are also curious about what has happened in the past and what is happening now on the ISS. Looking back at the distributions of what groups reported learning directly from the activities, human connections about survival continue to show up consistently in what groups are curious about, but they were less likely to mention the more factual information pieces about planets and technology. Instead, it seems like they want to continue exploring questions about human space missions.

This is backed up by observations that reveal participants were full of curiosity and wonder about various aspects of space exploration and the practicalities of living in space. They frequently asked questions and engaged in discussions about survival needs, such as how to ensure a steady supply of air and water, the challenges of hygiene in a microgravity environment, and the role of plants in producing oxygen. This curiosity was not limited to survival but extended to thriving in space, with conversations about the importance of comfort items like computers and TVs, and the feasibility of bringing pets or musical instruments to enhance the quality of life in a space habitat.

Additionally, participants expressed curiosity in the broader implications and future possibilities of space exploration. Both adults and children were intrigued by the idea of studying abroad on the moon or the potential for humans to establish long term habitation sites on Mars. Questions about current and past space missions, such as the Artemis mission and the historic Challenger

Fig. 18: Codes for responses to question "Was there anything you were wondering about or places you wanted more information?" (n=58)

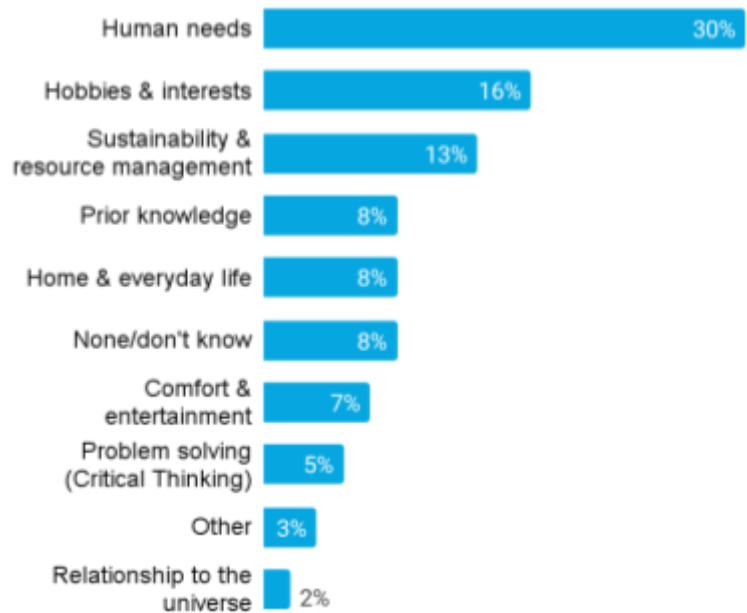


explosion, sparked further interest and led to discussions about advancements in space technology and the evolving goals of space exploration. Participants were eager to learn more about the challenges and innovations in space travel, showing particular excitement about how modern-day endeavors like SpaceX and Elon Musk's projects are shaping the future of human space exploration. The activities seemed to ignite a desire to continue learning about the various scientific, technological, and engineering aspects of space travel and the potential for human habitation beyond Earth.

Relevance: How did the activities connect to daily life?

When asked what kind of relevant connections they made between their lives and the activities (Fig. 19), groups most frequently gave examples about the need to meet basic human needs – surviving and thriving in a general sense. This included meeting essential human needs for survival like oxygen, water, and food as well as maintaining health and wellbeing, and this was consistent regardless which activities they experienced. Groups also made connections to existing hobbies and interests (e.g., LEGOS, art and drawing), which was more common when a group has experienced Moon Base or Space Medallion, and themes about the need to conserve or manage resources both during human space exploration missions and the need to conserve and manage resources on Earth. There may be a relationship between the ages of children in the group and some relevant connection topics. Groups that included younger children were less likely to make connections to basic human needs, but more likely to recall hobbies and interests. It is possible this reflects the affinity for LEGOS among younger children using the Moon Base activity.

Fig. 19: Codes for responses to question "What in your daily life connects to something you learned or did in this activity?" (n=40)



A smaller number of groups also cited prior knowledge about space and human space exploration (for example content learned at school, or through popular media), similarities to their everyday lives (e.g., food preparation, bedrooms, pets), and a small handful remarked on engaging in some deeper reflection on their place in the universe while considering the possibilities of human space exploration.

Observers also noted that groups frequently made personal connections and found relevance to their daily lives while engaging with the activities. These connections often stemmed from discussions about their interests, hobbies, and experiences. For instance, participants shared

stories about their pets, such as a child expressing a desire to bring their dog to space or another mentioning their fish and the need for a lid on the tank in space. Some participants drew parallels between their moon base designs and structures they had built with Lego, while others discussed their love for art and how they enjoy drawing.

Additionally, observers heard groups frequently connect the activities to their everyday routines and habits. Discussions about hygiene in space prompted jokes and comments about brushing teeth and staying clean, with one child joking about the need for hygiene in space for a month-long stay in close quarters. Other conversations revolved around familiar activities like camping and the amount of water needed, or the comfort of having a sofa to sit on in space. These connections likely helped participants see the practical applications of the concepts discussed and foster a deeper understanding of the challenges and requirements of human space exploration.

Problem-solving was not a connection that many groups made in their survey responses, but observers noted that participants frequently showcased this 21st-century skill in innovative ways. Participants were seen testing different theories and adjusting their strategies based on immediate feedback. For example, in the Breath of Fresh Air activity, one child persisted in proposing new theories about the chemical reactions, modifying their approach each time the facilitator advanced the activity. Similarly, in the Moon Base activity, groups faced structural challenges, such as unstable towers, and collaboratively found solutions, such as reinforcing the base with a Lego platform slab to ensure stability.

These problem-solving instances often intertwined with personal relevance, enhancing the engagement and practical understanding of the participants. For example, a participant likened the construction of their moon base to their experiences with Lego, connecting their familiar hobby with the task at hand. Another participant incorporated real-life knowledge about insulation and radiation shielding when deciding how to use the gold foil, further grounding their problem-solving in tangible experiences. These personal connections likely made the activities more engaging along with providing a context for the participants to apply and expand their knowledge. This blend of problem-solving and personal relevance created a rich learning environment where participants could see the direct application of their solutions in a human space exploration context.

In what ways does the project influence participants' attitudes about human exploration and NASA missions?

Roughly a quarter of groups reported an increase in excitement to learn about space exploration (Fig. 20), but very few reported increases in science identity or 'feeling like a science person' after experiencing the activities (Fig. 21). Increases in agreement about excitement to learn (Fig. 22) were statistically significant, but changes related to science identity (Fig. 23) were not.

Fig. 20: "I am excited to learn more about human space exploration" change in agreement

Fig. 21: "I consider myself a 'science' person" change in agreement



Fig. 22: Agreement/Disagreement with statement "I am excited to learn more about space exploration" BEFORE and AFTER the activities

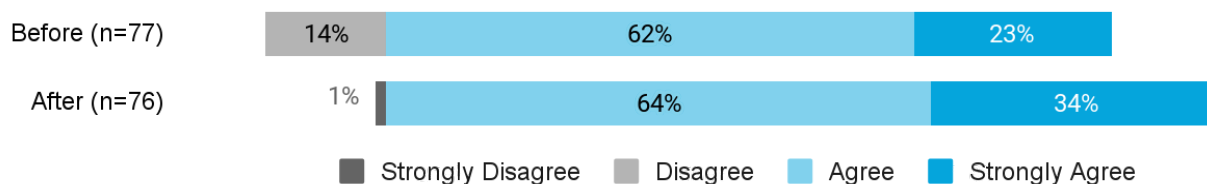
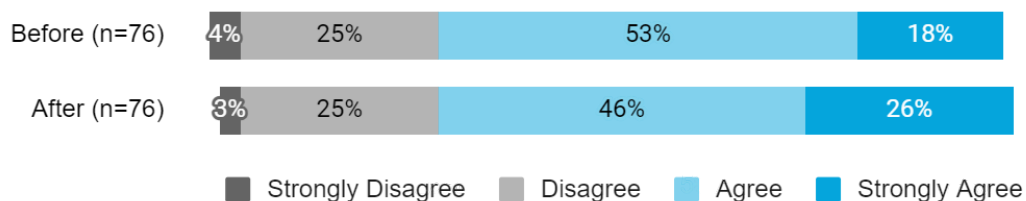


Fig. 23: Agreement/Disagreement with statement "I consider myself a 'science person,'" BEFORE and AFTER the activities:



DIY App

There were 10 DIY App activities that were evaluated: In or Out Game, Space Suit Selfie, Mars Rover, Planet Walk, Breath of Fresh Air, Space souvenir, Ice Orbs, Pack your Bags, Solar System Trek, Space Garden

Are activities engaging for public audiences?

Participants were asked to rate how enjoyable (Fig. 23) and interesting (Fig. 25) the individual activities offered through the DIY Solar System App were.

For the most part, two-thirds to three-fourths of groups found the activities they used "Enjoyable" or "Very Enjoyable," with Space Garden, Breath of Fresh Air, Code a Mars Rover, and Ice Orbs getting some of the highest ratings. The digital and AR activities (denoted by an asterisk in this section) received various ratings, but generally landed in the middle of the pack, though when disaggregated by age (Fig. 24) it appears the digital activities received a larger proportion of higher enjoyment ratings, and overall groups that included younger children (those under 8 years old) more frequently reported greater enjoyment. Fewer groups consistently gave high

enjoyment ratings for “Pack your Bags,” but groups with younger children were more likely to say it was very enjoyable (31%, n=13) compared to groups only with children 8 and older (7%, n=14).

Fig 23. How enjoyable were the following App Based activities?

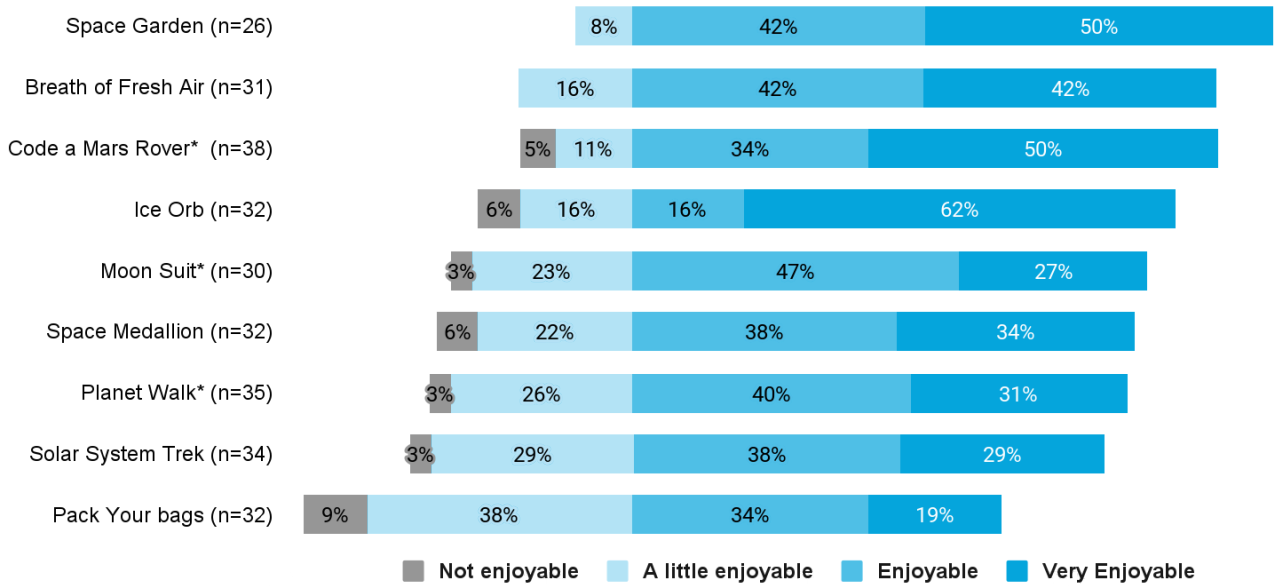
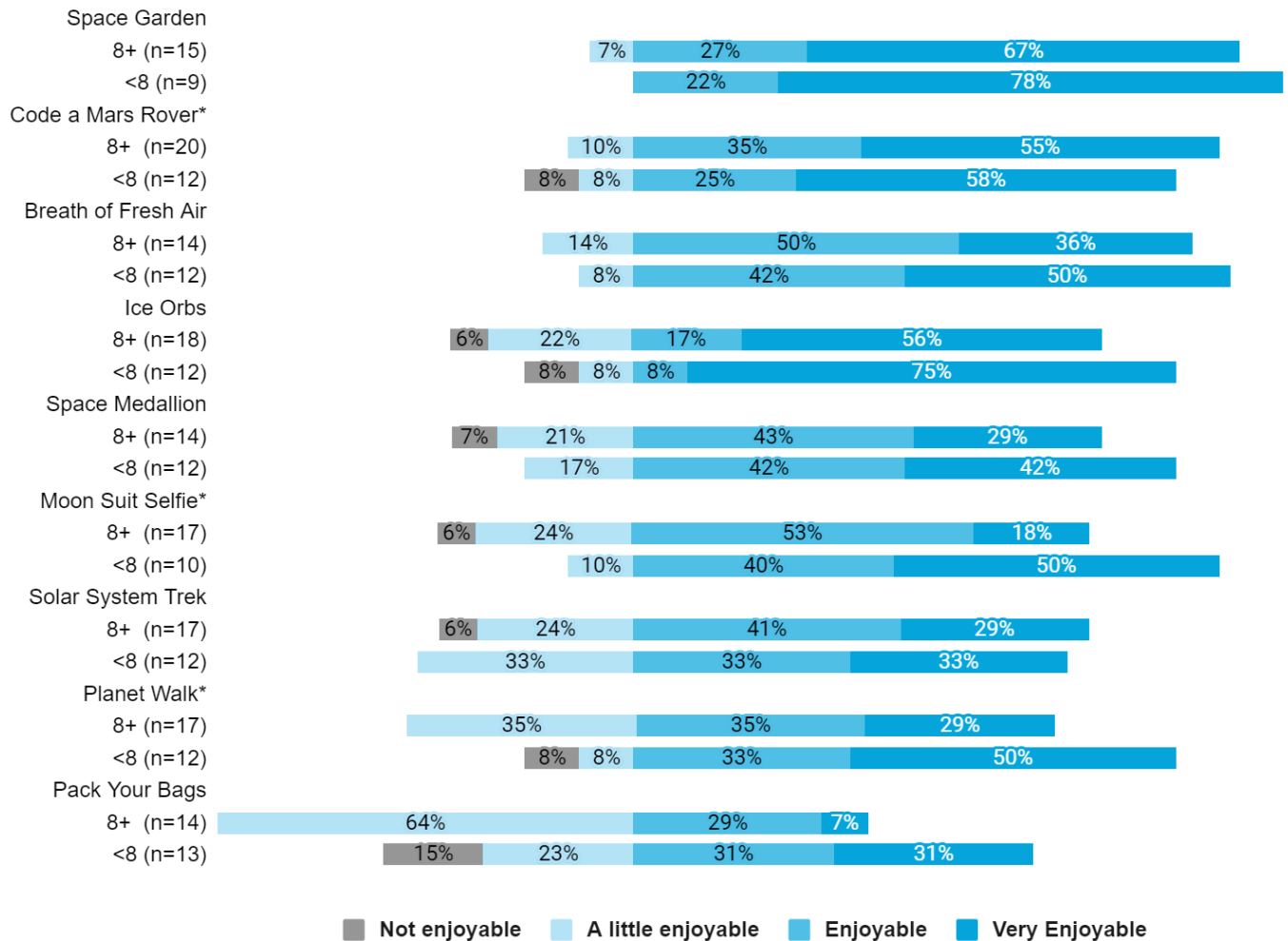


Fig. 24: How enjoyable were the App-Based activities? (Age)



Participants tended to give higher ratings for how interesting they found activities (Fig. 25). “Space Garden,” “Breath of Fresh Air,” “Ice Orbs,” and “Code a Mars Rover” once again received the largest proportion of highest ratings (“Very Interesting”). With the exception of “Code a Mars Rover,” these were activities that required more sustained engagement to come back and check on results (Space Garden and Ice Orbs) or piqued curiosity related to an unfamiliar substance (zeolite) and a visually exciting chemical reaction in Breath of Fresh Air. Age composition of groups (Fig. 26) was not as much of a factor in differences between how interesting groups found the activities, but the overall pattern does seem to be that the ratings trend higher when younger children were participating.

Fig. 25: How interesting were the following App-based activities?

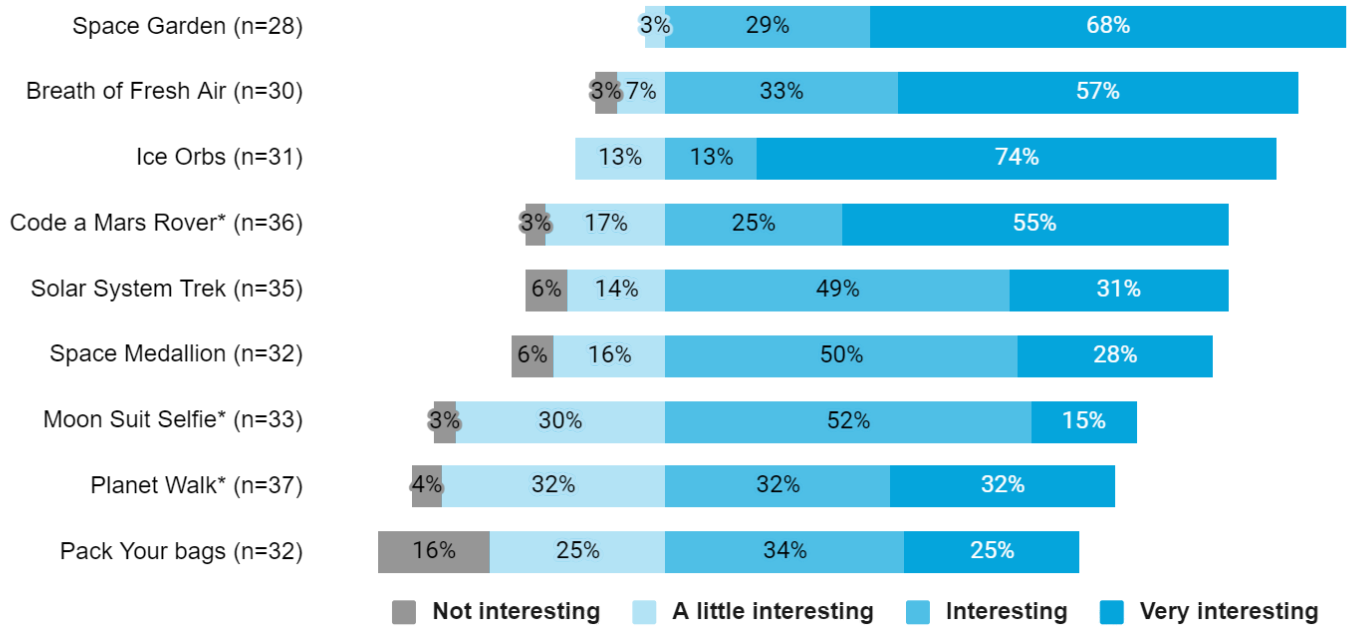
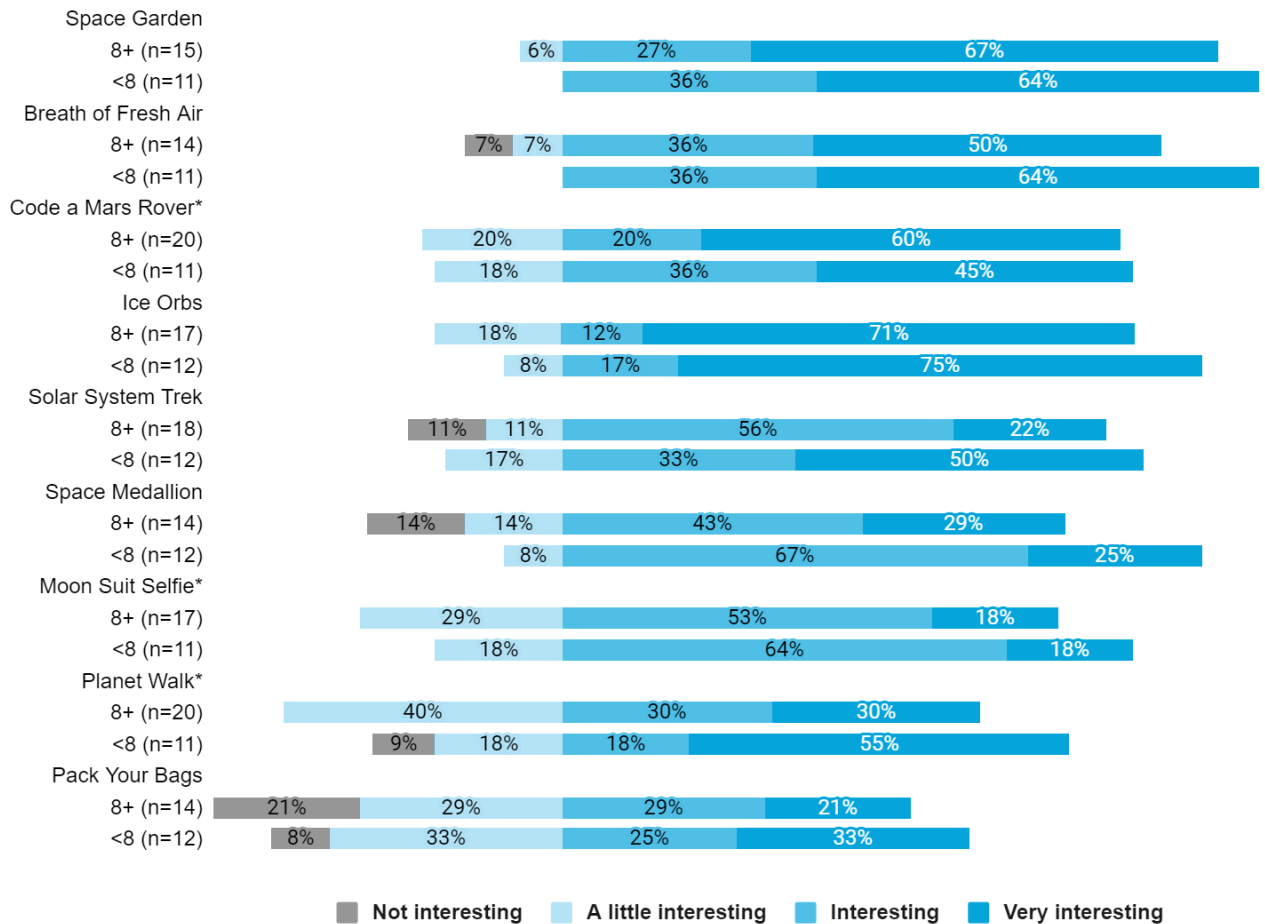


Fig. 26: How interesting were the App-based activities? (Age)



Insights from the interviews indicate the overall lower rating for the “Pack Your Bags” activity could be related to how challenging participants found it to complete, and the larger differences that emerge based on age composition might reflect the fact that conversations about what to pack and what choices or compromises need to happen was more engaging when younger children were involved..

In what ways do activities increase the public’s interest, awareness, and knowledge about space exploration, science, and engineering?

Nearly every group reported learning something from the App Activities (Fig. 27) and this is consistent when respondents were disaggregated based on the group composition (Fig. 28), though groups with younger children were a little more likely to report learning something. When asked to describe one or two things they learned about (Fig. 29) groups primarily mentioned factual information about space and planets, about the technology associated with space travel and exploration; the chemical reactions featured in the activities, and about human space exploration missions from the past. A smaller number of groups described learning about the human aspects of space travel such as the context around distance and the scale of space, what it takes to survive and thrive on extended space missions.

When disaggregating by age composition, groups that only included children 8 and older were more likely to report learning about human space exploration missions, the technology they employed, and chemistry concepts (Fig. 30), while groups that included younger children were far more likely to report learning basic facts about space and planets and the scale and distance of space.

Fig. 27: Did your group learn anything? (n=50)

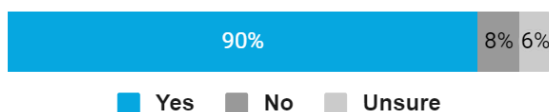


Fig. 28: Did your group learn anything? (Age composition)

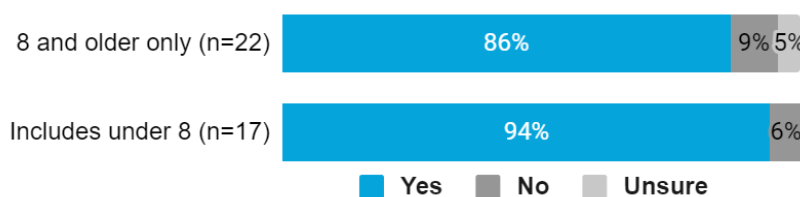


Fig. 29: What are one or two things you learned about? (n=43)

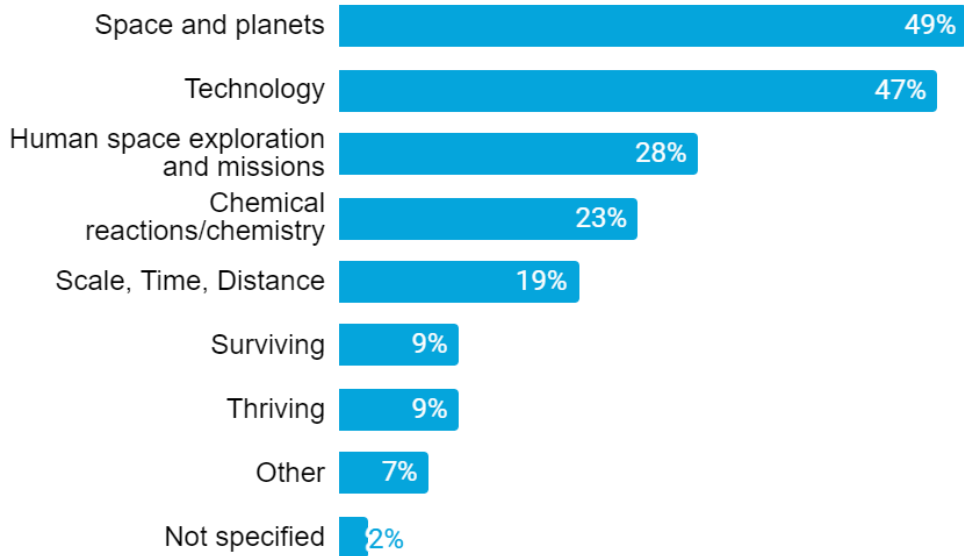
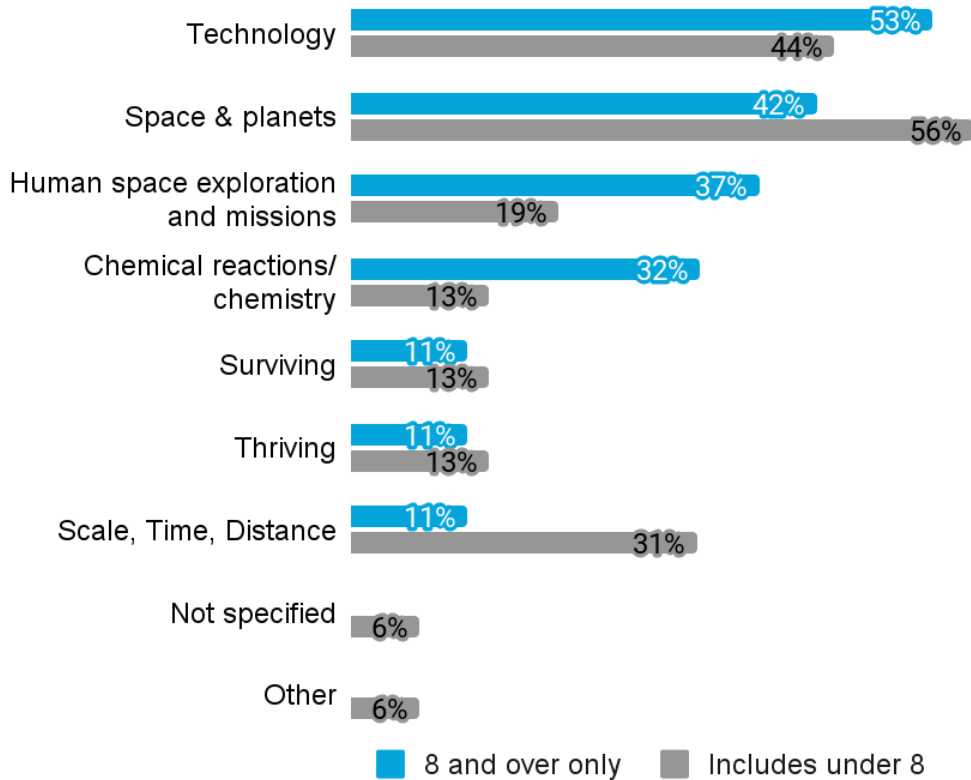


Fig. 30: What are 1 or 2 things you learned? (Age composition)



It's unsurprising that DIY App respondent did not mention facilitation as an aspect of the activities that made them want to learn more (Fig. 31) as they were conducted at home rather than onsite at the museum. Over half mentioned content related aspects, while a little under a third described the format. A small number gave a response that was germane to the question, but not specific enough to code in this rubric (e.g., "Everything!"). There were noticeable differences based on age composition, as nearly all groups that included younger children cited the content as making them want to learn more (Fig. 32), whereas only about a third of groups comprised only of older children mentioned something that was coded as "Content."

Fig. 31: What about the Activities Made you want to learn more? (n=47)

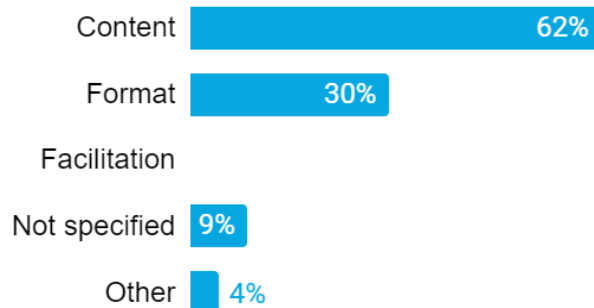
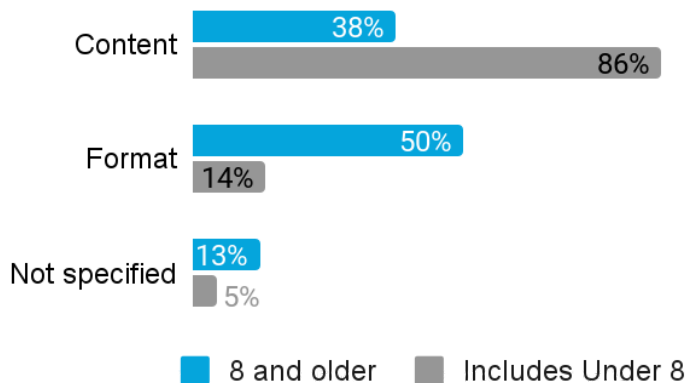


Fig. 32: What about the activity made you want to learn more? (Age composition)

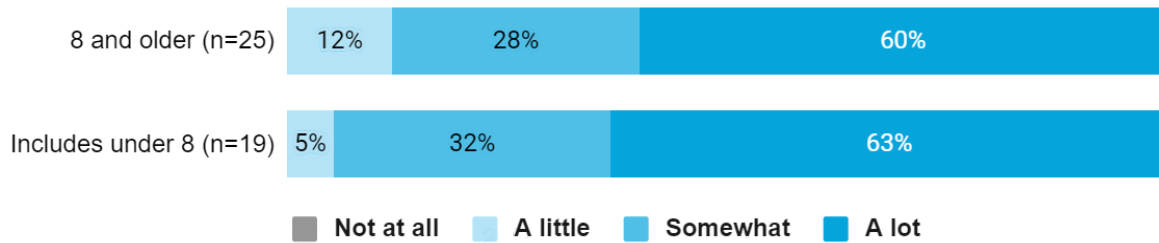


Every group reported that the DIY app activities connected to human space exploration at least "A little," and over half reported that it did so, "A lot" (the highest rating) (Fig. 33). There weren't very noticeable differences when disaggregating by age composition in groups, but those that included younger children reported stronger connections slightly more frequently (Fig. 34).

Fig. 33: Overall, how much did the app connect to human space exploration? (n=50)



Fig. 34: Overall, how much did the app connect to human space exploration? (Age composition)

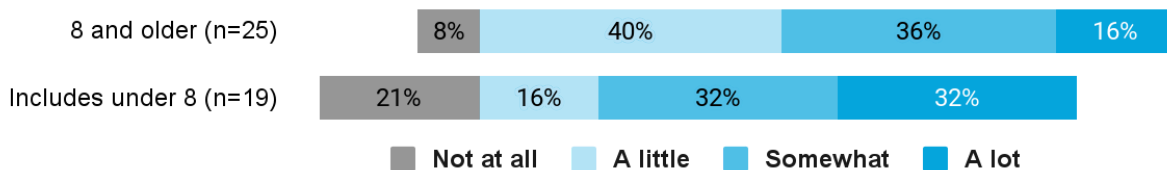


An overwhelming majority (88%) of groups said that their interest in learning about human space exploration had increased after using the app (Fig. 35). Any increased interest among groups that included younger children was reported less frequently than those with older children only (Fig. 36), but was seen in more than three-fourths of those participants, and about a third reported that their interest had increased “a lot.”

Fig. 35: How much has your interest in learning about human space exploration and NASA's return to the moon increased after using the app? (n=50)



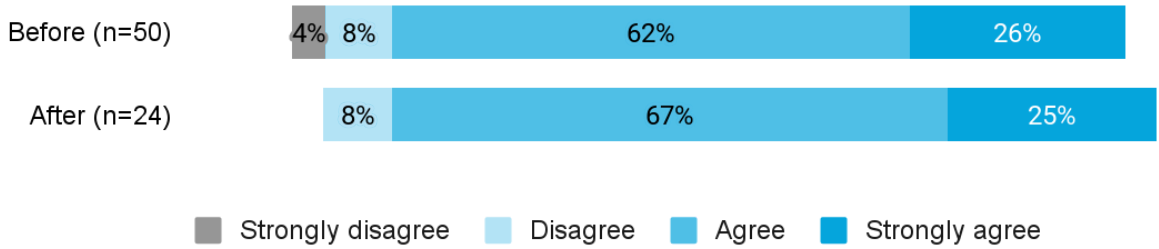
Fig. 36: How much has your interest in learning about human space exploration and NASA's return to the moon increased after doing this activity? (Age Composition)



Over 90% of respondents said they “Agreed” or “Strongly agreed” with the statement “I am interested in space exploration.” Participants in the DIY app evaluation were primarily recruited from SMM members, and also included some households who were recruited during a visit to the museum, so pre-existing high levels of interest in space exploration (Fig. 37) is not surprising and was also evident in all the interview participants. About a quarter of groups’ before and after ratings indicated a statistically significant increase in interest, but most (58%) showed no change, and about a fifth (20%) seemed to show a decrease².

² Respondents were asked to rate their agreement with the statements “now” followed by reflecting on how they would have answered “before using the app” so each set of ratings was matched. The distribution of “increase/no change/decrease” was calculated based on any movement up or down the rating scale, so someone reporting they “Strongly disagreed” before and “disagreed” after would be noted as having “increased their agreement. Likewise someone who “Strongly agreed” with a statement before moving to “Agree” after would be coded as “decreased agreement.”

Fig. 37: Agreement/Disagreement with the statement “I am interested in space exploration” BEFORE and AFTER the activities:



A little more than half (56%) of respondent groups indicated they “Agree” or “Strongly agree” with the statement “I am knowledgeable about space exploration (Fig. 38) before using the app, indicating there was potentially more room for growth, however it does not appear very many experienced an increase in knowledge, and as with interest, the majority (58%) reported no change and nearly a third reported a decrease in agreement (Fig. 40), though these changes were not statistically significant.

Fig.38: Agreement/Disagreement with the statement “I am Knowledgeable about space exploration” BEFORE and AFTER activities:

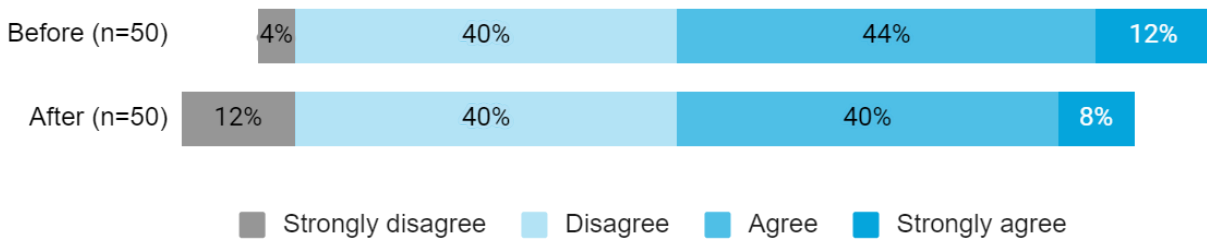


Fig. 39: “I am **interested in space exploration**” change in agreement

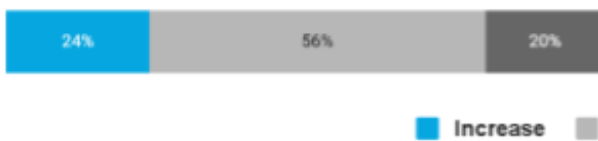
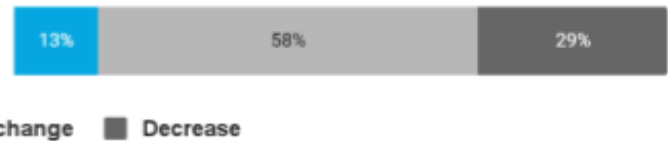


Fig. 40: “I am **knowledgeable about space exploration**” change in agreement

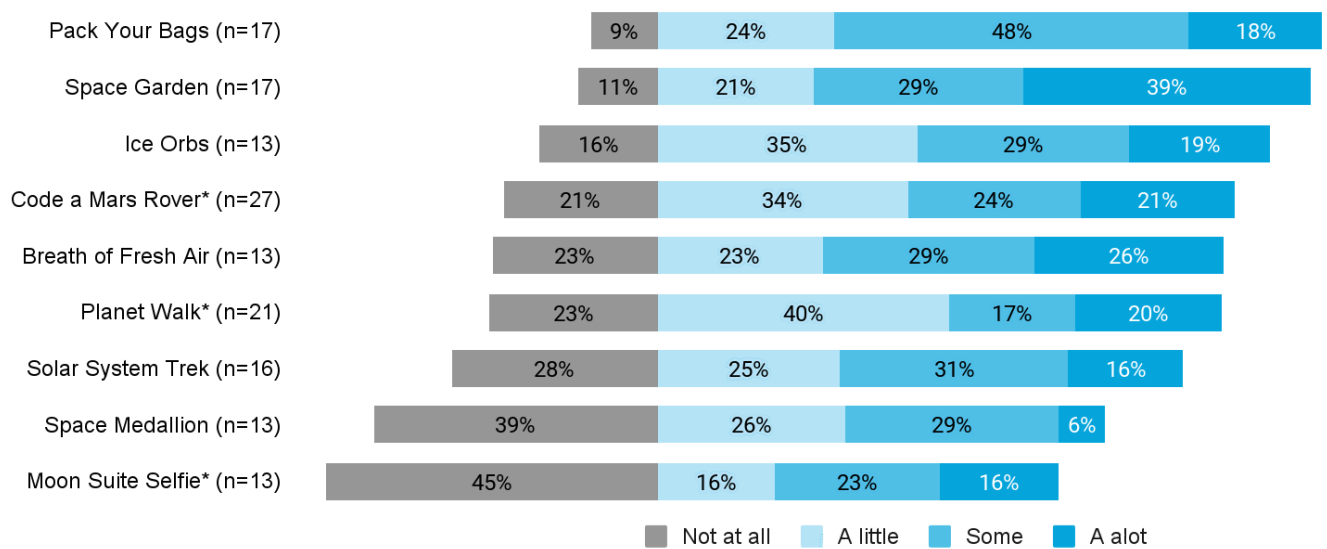


At least half of groups reported that each of the DIY App activities was at least “a little” relevant to their daily lives (Fig. 41). With the exception of Space Medallion and Moon Suit Selfie, it was about three-fourths that found the activities at least “a little” relevant.” Whereas “Pack Your Bags” was generally rated lower regarding how enjoyable and interesting the activity was, very few

groups did not find it relevant to their daily lives, and it was among the top four most relevant activities along with “Space Garden, Ice Orbs, and Code a Mars Rover.”

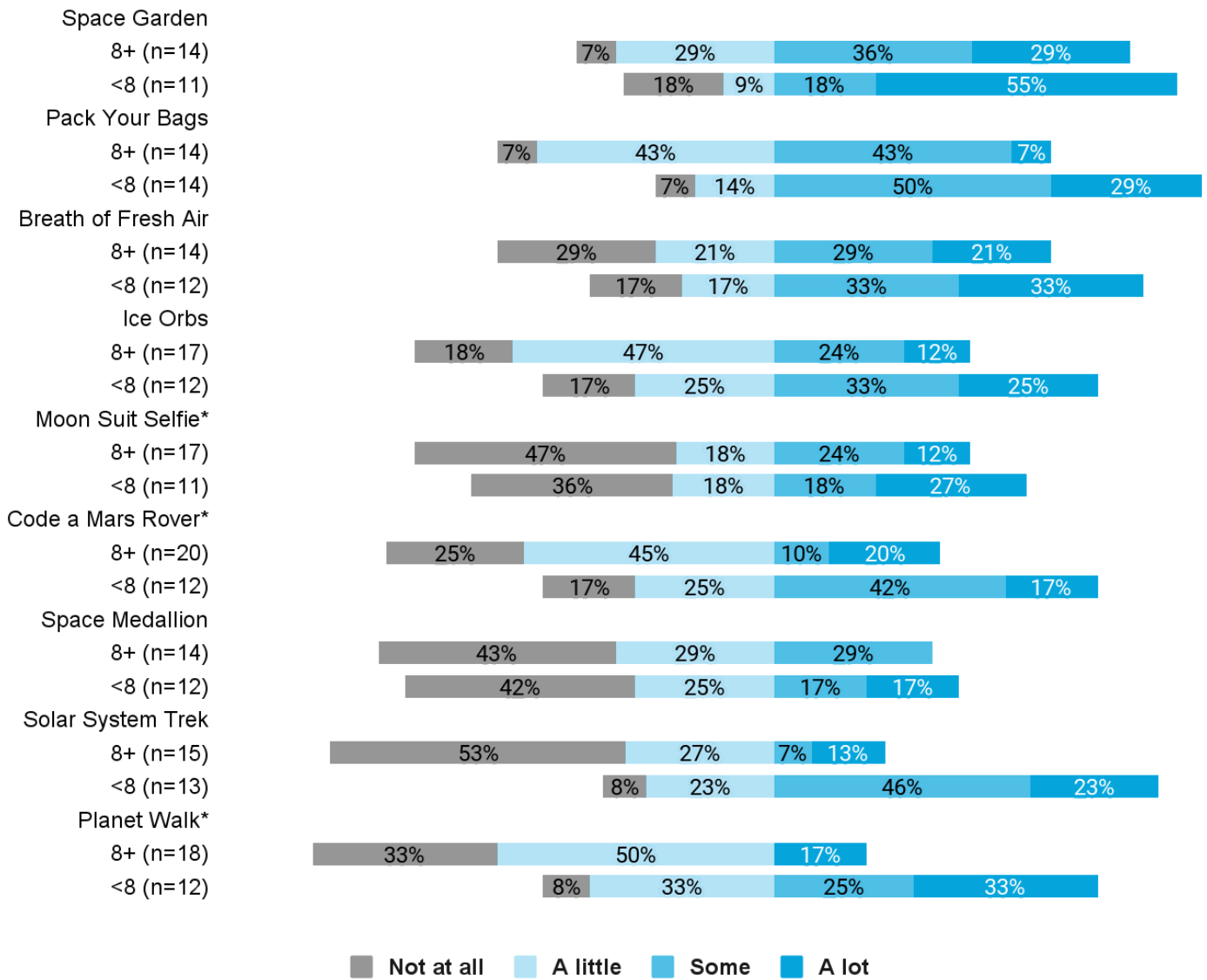
Based on insights from interviews, groups made daily relevance connections to their home vegetable gardens (Space Garden) and experiences they have had with coding activities they have done at school and camps (Code a Mars Rover), and the task of needing to choose a limited number of personally relevant items for a long space mission also came up (Pack Your Bags). It is unclear why Ice Orbs was seen as having particular daily relevance connections, though one interview group did talk about the connections to oceans and the existence of water on other planets.

Fig. 41: How Relevant were the individual activities to your daily life?



When disaggregated by age composition, it appears that groups that included younger children were more likely to report that activities were more relevant to daily life (Fig. 42) with the most notable differences in rating distributions in response to the “Solar System Trek,” “Planet Walk,” and “Code a Mars Rover” activities.

Fig. 42: How relevant were the activities to your daily life? (Age)



When asked how the DIY App activities remind them of their daily lives (Fig. 43), the most frequent type of response alluded to hobbies and personal interests (video games and computer coding, gardening, cooking), home and everyday life, and connections to prior knowledge about space, planet, and human space travel that they learned about through their own reading, prior museum visits, or at school. Other connections were about basic human survival (e.g., eating and drinking, breathing) and more abstract connections like needing to apply problem solving skills and reflecting on humanity’s broader relationship to the universe. The most notable difference when considering age composition of groups is that those that included younger children were less likely to mention hobbies, make connections to everyday home life, or draw on prior knowledge. Groups with younger children were more likely to comment that the activities reflected the basic human survival needs (Fig. 44).

Fig. 43: How did the activities remind you of daily life? (n=45)

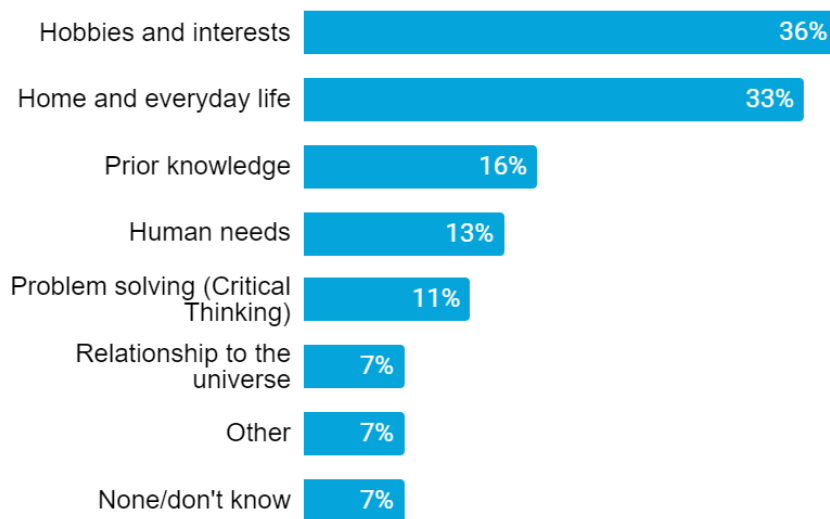
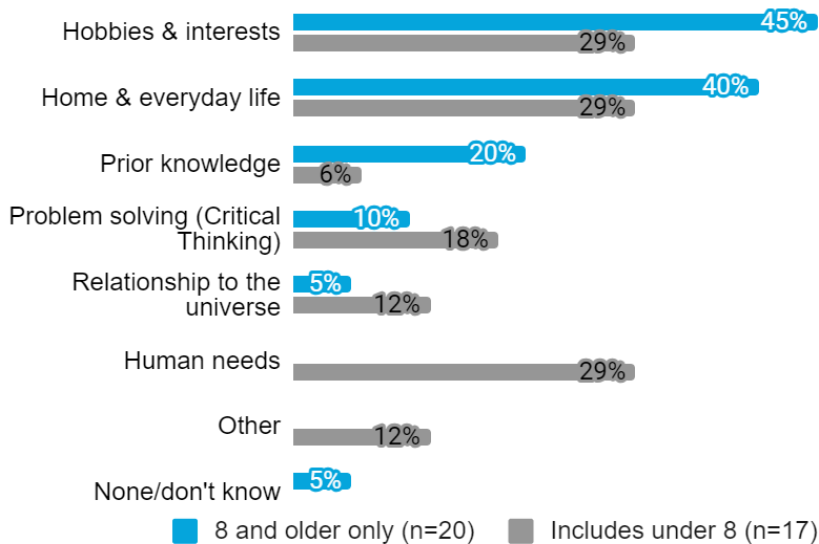


Fig. 44: How did the activities remind you of daily life? (Age composition)



Respondents were asked what they were curious or wondering about while using the DIY App activities. Similar to the museum-based activities, the coding rubric for these open-ended responses was based on the codes used for the question “What are one or two things your group learned?” (as it could be understood as a desire to continue learning about ideas and content related to the activities) with the addition of a category about questions related specifically to the activity (e.g., “What is zeolite?”) and “Future human space exploration missions.” Just about half of groups indicated they were curious or wondering about past and present human space explorations, and a quarter mentioned things that ended up in the “Space and Planets” category. (Fig. 45) A smaller number mentioned technology used by astronauts during missions (e.g., Space suits) and wonderings about future space exploration missions and eventual human habitation on other planets.

Groups that included younger children reported curiosity about past space exploration missions, long with wonderings about surviving and thriving in space much more frequently than groups with only older children who were more likely to want to keep learning about future human space exploration, the technology astronauts rely on during the missions, and information about planets and the universe (Fig. 46).

Fig. 45: Is there anything you were curious or wondering about? (n=48)

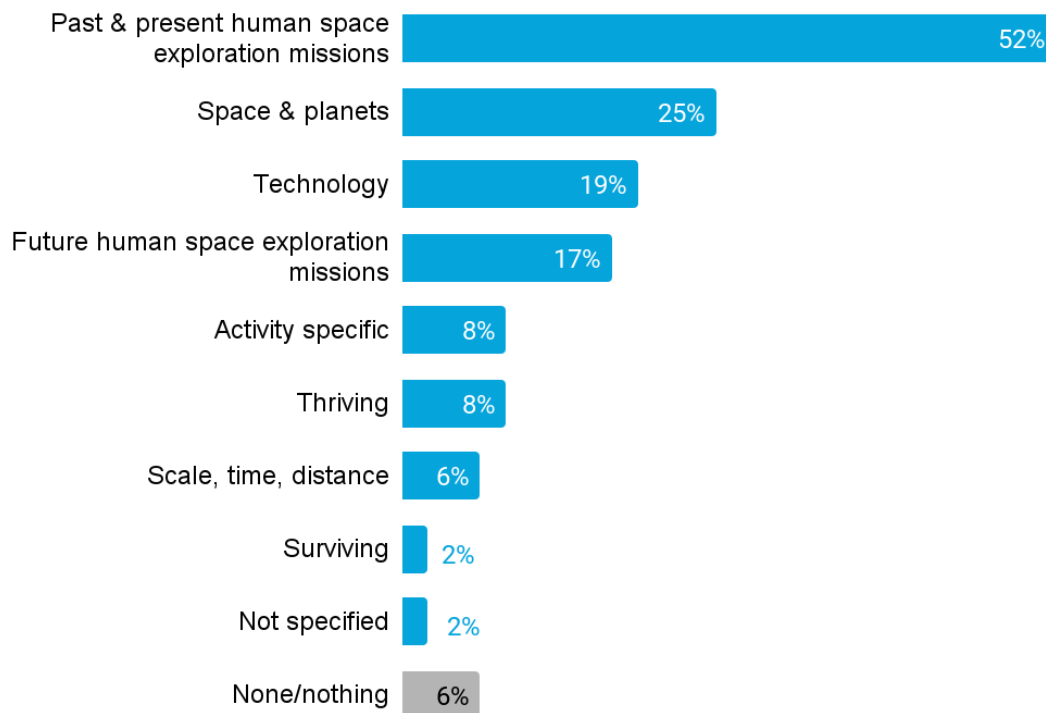
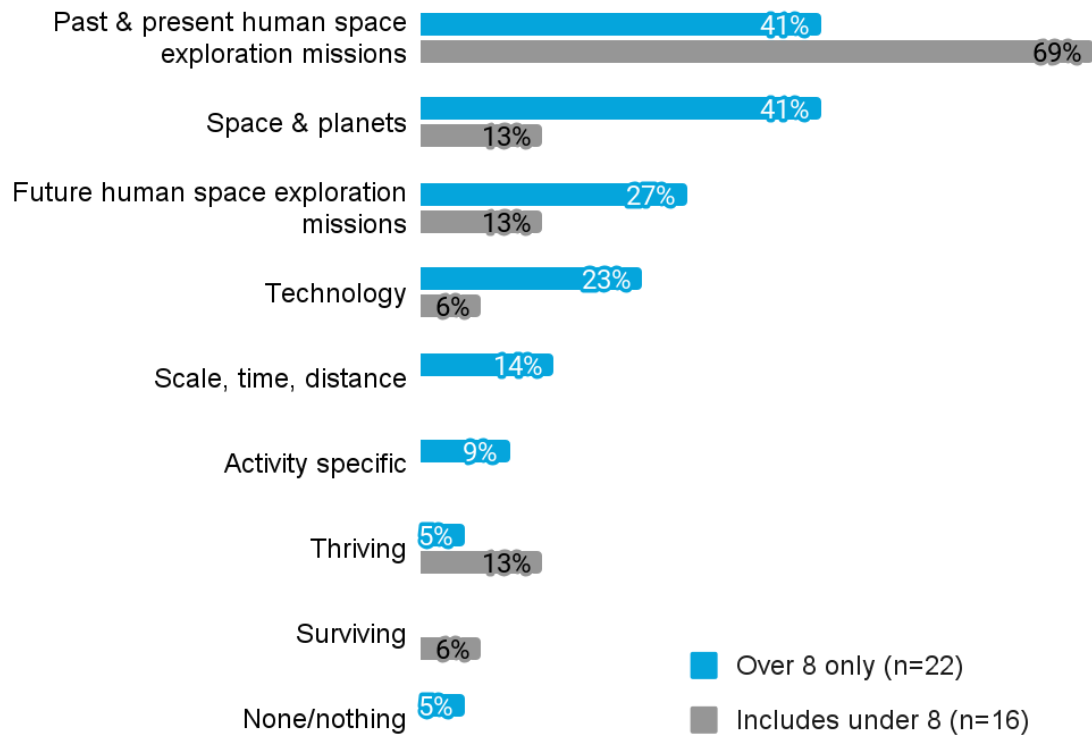


Fig. 46: Is there anything you were curious or wondering about? Age



In what ways does the project influence participants' attitudes about human exploration and NASA missions?

As mentioned above, DIY App summative participants were primarily recruited from among SMM's membership base, meaning pre-existing excitement about space exploration and robust identity as "science people." was to be expected, however the proportion of groups reporting that they strongly agreed with the statements "I am excited to learn more about human space exploration" appears to have decreased from 30% to 22% (Fig. 47) after using the app activities there doesn't appear to be much, if any statistically significant changes to the distributions related to the statement "I consider myself a 'science person,'" (Fig. 48).

However survey responses to the question "What about the activities made you feel like a NASA astronaut or scientist?" do indicate the the digital and AR components of the app, specifically, provided an immersive experience that enabled participants to feel like they were involved in space exploration. They highlighted the hands-on experience of coding and plotting paths for a Mars rover, which simulated real-world tasks astronauts undertake and shared that choosing the appropriate space suit for different environments enhanced their sense of being an astronaut. The visual elements, such as seeing one's face in a space suit or exploring planets through AR, further reinforced this feeling.

Fig. 47: Agreement/Disagreement with the statement “I am excited to learn more about human space exploration” BEFORE and AFTER activities:

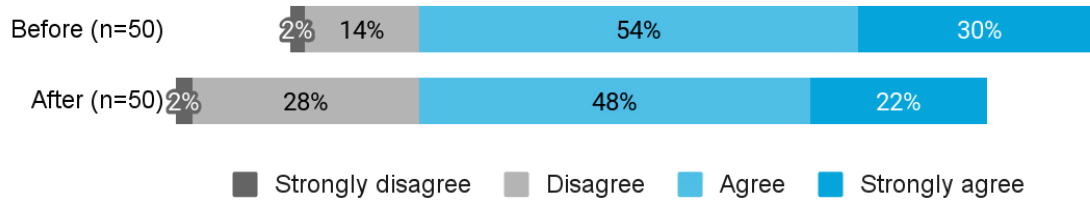


Fig. 48: Agreement/Disagreement with the statement “I consider myself a science’ person” BEFORE and AFTER activities:

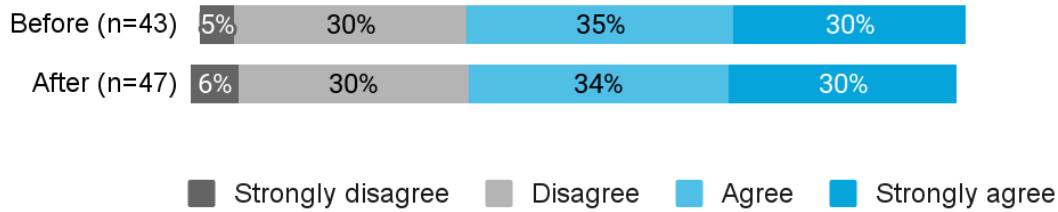


Fig. 49: “I am **excited to learn more about human space exploration**” change in agreement

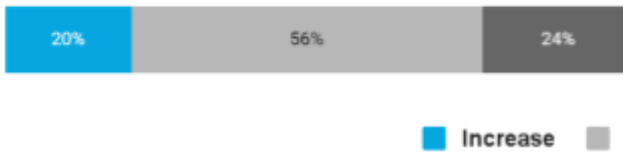
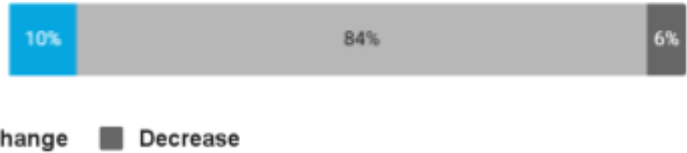


Fig. 50: “I **consider myself a ‘science’ person**” change in agreement



Interview Summaries

The interviews with groups who tested the DIY Solar System App were initially intended to provide more detailed structured feedback on how the app increased interest in and knowledge about human space exploration, and the ways it contributed to a sense of being a "science person." However, the conversations evolved into more informal discussions that allowed participants to share their experiences, highlights, and suggestions for improvement. This approach provided valuable insights into how the app was used in a home setting, revealing both the strengths of the app and areas where enhancements could be beneficial.

Participants across the board praised the app’s user-friendly design and the enjoyment it provided. Groups consistently noted that the clear instructions for the activities and intuitive navigation enabled children to explore and interact with the app independently if they desired. For instance, Group A and Group B highlighted the effectiveness of the app’s interface and the immersive AR features, such as the Planet Walk, which offered a visually engaging experience that set the app apart from traditional museum experiences and programs. This aspect allowed groups to explore planetary surfaces in a dynamic way, enhancing the home learning experience.

The educational value of the app was a significant theme in the feedback. Activities like the "In and Out" game and the space garden were frequently mentioned for their ability to spark curiosity and deepen understanding of space. Group C and Group D appreciated how these activities reinforced existing knowledge and introduced new concepts, such as different astronaut suits and the practical applications of space science. They found the app especially valuable and effective for making complex topics accessible and engaging.

"Participant 1: I didn't learn new stuff, but I think it was mostly because I knew most of the stuff earlier on, [...] I knew some of the things

Participant 2: I think you're exactly right. You knew a lot going in, and had a reasonable interest, so I think this reinforced a lot of her knowledge, some fun activities that were interesting to do, a few new pieces of knowledge that we didn't know. But I think she already was kind of a science person to begin with."

~Group C

Despite the positive reception, replay value emerged as a concern. Several groups, including Group A and Group E, indicated that some activities felt repetitive and suggested that adding elements of unpredictability and challenge could enhance long-term engagement. This feedback suggests that incorporating more varied and interactive content could improve the app's ability to maintain user interest over time.

"... he did a whole project on Mars for school last year, and it was so cool. Like he made a board game out of it. He made his own board game. And it was interactive and fun, and something we can keep going back and playing different cards, different scenarios each time. And just trying to make it a little bit more unpredictable. Kind of like that's just – you know, just follow the map, you know. Or like we said, make it a little bit like harder to reach. We really reached all the planets quick."

~Group A

Respondents also highlighted the connections to their own lives, which added meaningful context to their learning experiences. For example, Group C related the Ice Orbs activity to winter experiences in Minnesota, and Group B drew parallels between the app's content and everyday scenarios, such as the practical application of air filtration and how spacesuits help us adapt to different extreme weather conditions, demonstrating how real-world connections can enhance the relevance of the app's educational content..

"...as far as spacesuits I'm thinking we need to wear different clothes in different – like, if it's really hot out you wear short sleeves and if it's really cold out you have to wear a coat."

~ Interview Group B

Overall, the tone of feedback was positive, with a strong appreciation for the app's interactive and educational features tempered by constructive suggestions for improvement. Groups were enthusiastic about the app's ability to engage and educate, yet they also pointed out areas for enhancement, such as increasing activity diversity and challenge. Addressing these suggestions will be key to maximizing the app's effectiveness and sustaining user engagement.

Museum-based Activities Compared to DIY App

While this evaluation was never intended to directly compare the museum-based activities and the DIY Solar System App, evaluators opted to briefly consider findings side by side to identify any notable differences, since data collection relied on parallel instruments wherever possible. That review is presented in the following section

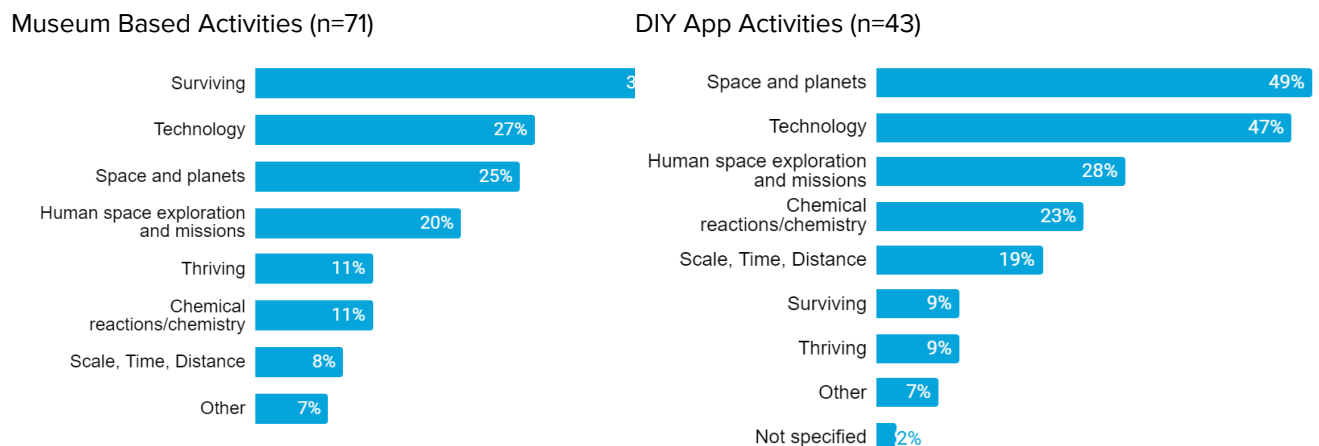
Enjoyment and Interest

All respondents reported museum-based activities were at least a little enjoyable and interesting, and nearly all gave the highest two ratings on the four-point scale. Museum-based activity respondents were asked to rate their entire experience, which may have included one, two, or all three offerings, and it is possible social desirability may have played a role in groups generally providing higher ratings, but the facilitation of the activity in the museum environment could also have played a role. DIY App participants were asked to rate each activity they used individually, and a small number of respondents gave the lowest rating on the four-point scale (“not enjoyable” and “not interesting”) for the DIY and digital app activities, and there were more respondents who gave the second lowest rating of “a little” regarding how enjoyable and interesting the activities were.

Learning

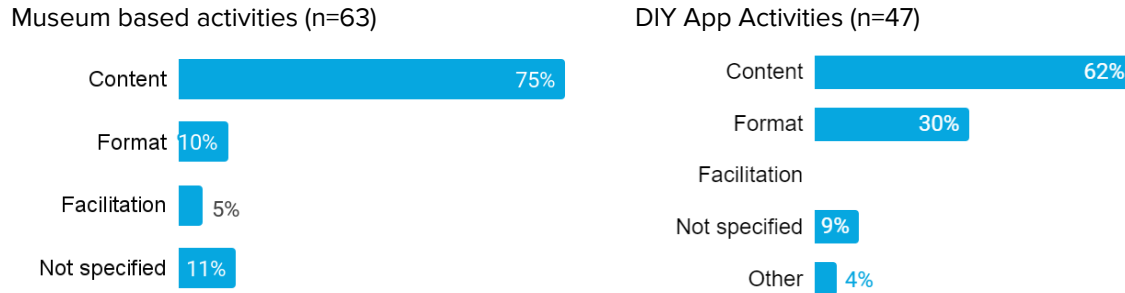
The proportion of groups that reported learning something from the activities is similar regardless of setting and if it was DIY or facilitated by an educator, but it may be that the museum-based activities provided more opportunities for learning about the human connections in space exploration while the DIY activities better highlighted factual information (Fig. 51).

Fig. 51: What are one or two things your group learned about? Comparison



Content was cited by more than half of respondents in both conditions (Fig. 52) as the reason they wanted to learn more about human space exploration, but the format of the activities played a larger role among the DIY App participants.

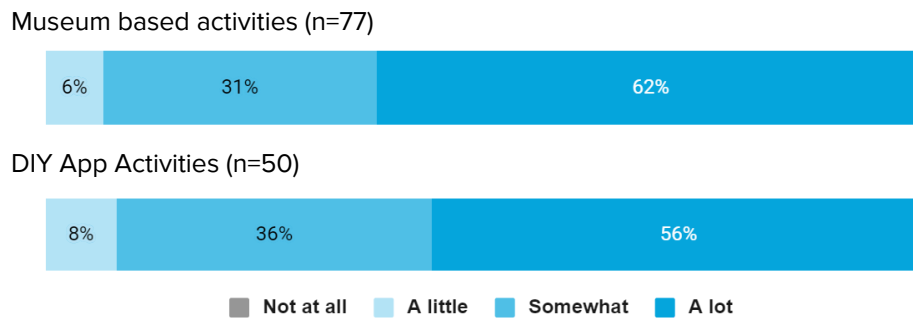
Fig. 52: What about the Activities made you want to learn more? (Comparison)



Connections to Human Space Exploration

Responses to the question, “How much did the activities connect to human space exploration?” showed a nearly identical distribution between the two products (Fig. 53), with the museum based activity respondents reporting slightly stronger connections.

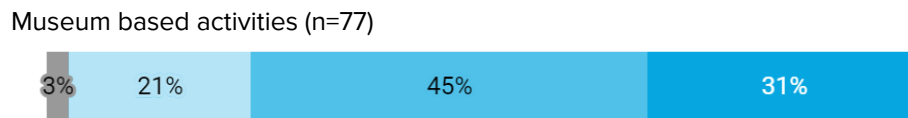
Fig. 53: How much did the activities connect to human space exploration?



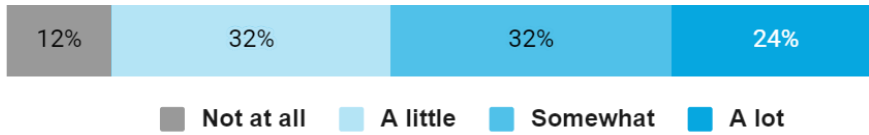
Interest in Learning More about Human Space Exploration

Respondents who experienced the facilitated Museum-based activities indicated a greater degree of increased interest in learning about human space exploration, with 76% reporting “somewhat” or “a lot” compared to 56% of DIY App participants (Fig. 54).

Fig. 54: How much has your interest in learning about human space exploration and NASA’s return to the moon increased? (Comparison)



DIY App Activities (n=50)



Attitudes: Changes in Agreement

Participants who experienced the Museum-based activities were more likely to report increased agreement with statements regarding space exploration after experiencing the activities compared to groups that tried the DIY App activities. Changes in attitudes about seeing themselves as “science people” seemed to be about the same between the two products, and both groups also started with fairly similar distributions.

Table 2: Increase in agreement from Before to After experiencing activities

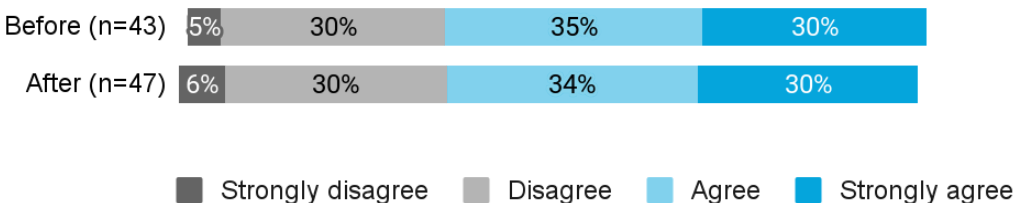
	Museum-based	DIY App
I am interested in space exploration	34%	24%
I am knowledgeable about space exploration	28%	13%
I am excited to learn more about human space exploration	32%	20%
I consider myself a ‘science’ person	13%	10%

Fig. 55 Agreement/Disagreement with statement “I consider myself a ‘science person,’” BEFORE and AFTER the activities (Comparison)

Museum-Based Activities



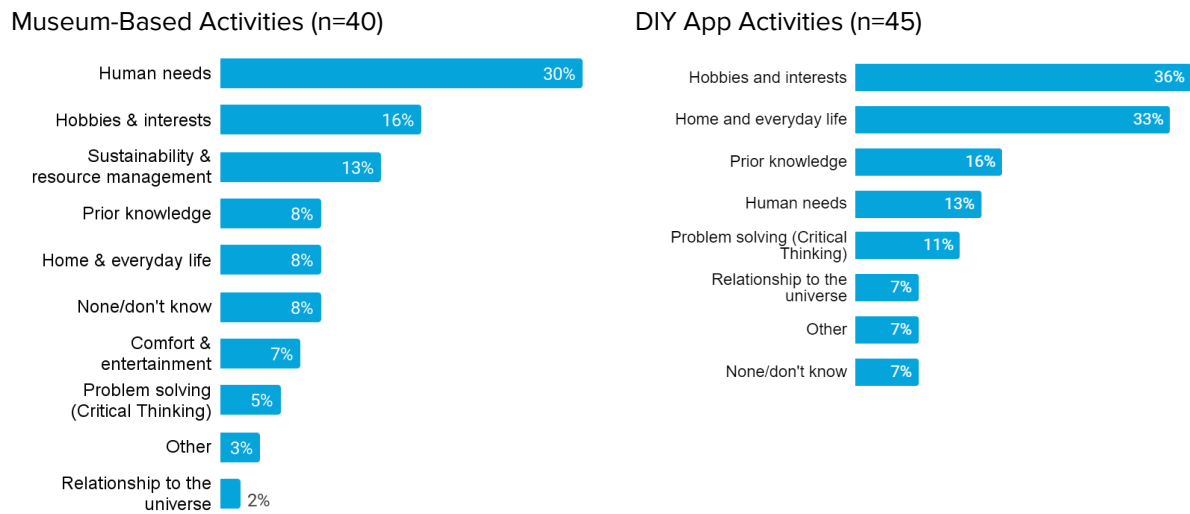
DIY App Activities



Relevance and Connections to Daily Life

Participants who experienced the Museum-based activities were more likely to reference how the activities and the ideas in them related to human needs like eating, drinking, breathing than the DIY App participants, who most frequently described hobbies and other personal interests. Relevance connections are expected to be different between the two products given the different content covered and the contexts of the experiences, but it is worth noting that the activities generate different types of connections to daily life (Fig. 56).

Fig. 56 How did the activities remind you of daily life? (Comparison)

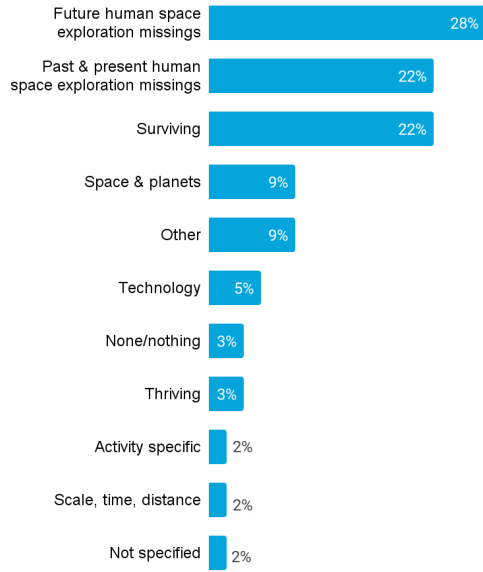


Curiosity and Wonderings

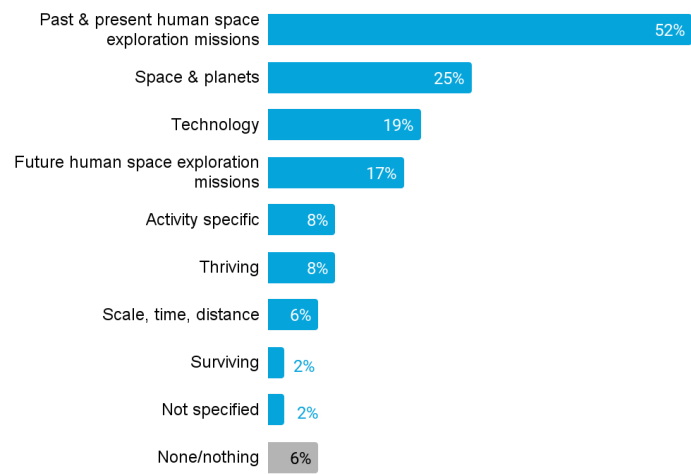
Museum-based activity participants more frequently shared that they were curious or wondering about *future* human space exploration missions while DIY App activity participants mentioned past and present human space exploration. DIY App participants were also more likely to say they had wonderings or were curious about space and planets in general and the technology employed in space exploration missions. This is also an area where different responses are expected on account of the ways the two products differ.

Fig. 57: Was there anything you were wondering about or places you wanted more information?
(Comparison)

Museum-based Activities (n=58)



DIY App Activities (n=48)



Appendix A: DIY App Supplemental Interviews

We provided 50 groups with materials necessary to do the activities in the DIY Solar System App and complete a follow up survey. We were able to schedule follow up interviews with five groups to hear more about their experience and get more details about their survey responses.

Each interview below is preceded by a summary of key ideas from the conversation, which was conducted via video interview. The transcripts are lightly edited to remove filler comments (e.g., “hmm”, “yeah” and “uhh”). Participants were not individually identified by the original transcriptionist, but it is usually clear when a speaker changes within the group. No group had more than three participants.

[Group A](#)

[Group B](#)

[Group C](#)

[Group D](#)

[Group E](#)

Group A: One adult; One child

Summary of Key Ideas:

- **Ease of Use and Enjoyment:** The app is easy to use and enjoyable. Clear and concise instructions are appreciated, enabling independent use by children. Ease of use makes it accessible, allowing children to engage with it anywhere.
- **Low Replay Value:** Many activities felt “one-off” and participants were not interested in repeating them. Adding elements of unpredictability and challenges to the games and AR interactives could enhance engagement and replayability.
- **Suggestions for Improvement:** Regular addition of new activities to maintain interest. Make activities more interactive and educational, incorporating challenges and random events. Include more factual information and realistic simulations. Activities like the planet walk need proper scaling to demonstrate planetary distances effectively.
- **Educational and Engaging Activities:** "In and Out" game is highlighted for its unpredictability and educational aspect, sparking curiosity and further research. Space garden activity teaches about hydroponics and provides ongoing engagement. Activities like ice orbs and plotting the solar system are practical and offer learning opportunities through hands-on experiences. Augmented reality and real-time views in the app are captivating and enhance the user experience.
- **Excitement and Curiosity:** Receiving and exploring materials creates excitement and curiosity. Predicting activity outcomes and revisiting activities to improve models mirror real scientific processes.
- **Real-Life Applications and Understanding:** Hands-on learning and real-life applications, such as growing plants in space conditions, teach problem-solving and resource management. Understanding Earth's place in the galaxy and potential life on other planets, emphasizing the diversity of life forms.

Interviewer:

The intention of this app is it mostly uses things that are available around the house, that they want it to be very easily accessible. We also know you might have tried other things other than what you were specifically assigned to do, which is fine. I just want to know what all you did. So I have you down from your survey, because I know that was a while ago that you did it the ice orb, so with the balloons. You did the solar system trek. The space garden, so you grew some things. You marked that you did the Code a Mars Rover. And you did did the planet walk and the In and Out game. Okay. Yeah. That's an easy one to do. Did you try out any of the other things?

Participant:

We talked about some of them without doing them, like the Pack Your Bags, and we talked about that, because he did a – he had a back to school activity, like they had to share stuff. And we talked about what we'd pack, and is it – like what would be useful in space, and also like something that you can remember from home, things that were – he's kind

of a practical kid. So when we talked with them, he's like, well, like a picture you can hang up, that's not going to float around, you know. Some of his comfort items, he's like, well, that would just float around. It wouldn't really – it'd just get in the way.

Interviewer:

And you only have – like you only have so much stuff for your personal stuff, so you have to make really hard choices. So – but yeah. Practical – if it's practical, and – those are important considerations. So first, I'm going to ask you some like big picture, overall questions. And then we'll have some time to dig into the specifics.

So when you think about overall using the DIY solar system app, how much did you enjoy using it and doing things, doing the things?

Participant:

Sure. I think the app is really – I mean, it's easy to use. I think a lot of it is like there's a lot of one-off activities, and then like you're not going to really go back to it, you know?

It's nice if they like keep uploading different activities to do, like hey, here's some new ones. I don't – you know, like monthly, a new monthly activity or something, or something that they can – because once you do it, it's like, okay, I did that. Because they're like science experiments.

And if you did it, you're not going to really try it – unless you need to try it again. We had a – we had to do ice orbs twice, because this person left _____ and they froze, and then they were like all solid in the bin. But, you know, I mean, trial and error, right?

Interviewer:

But doing the individual activities, that was fun and enjoyable, you'd say?

Participant:

Oh, we loved it. We love doing science experiments and drawing stuff and like trying different things.

The planet walk, you know, it was fun, and I don't know if we'd do it again, because it's like – what did we notice about the planet walk? We lined the planets up. It's not like – you have to like actually put it like really – like you have to have some really – it's like it doesn't _____ far the planets are from each other, because it's like – at least like three inches apart from each planet.

Like when you put them out there, you just kind of walk past. It's kind of fun to be able to like walk past them, but it's like – it wasn't like spaced far enough apart, where it's like we know like to get to Mars, it's going to take a long time, you know.

It'd be kind of fun if they did it like to the scale, like distance scale modified down, where like you could actually go, and like at mile marker one, you

actually get to a different planet. Something – you could maybe make it like more of a – like a journey to do. Because it just didn't feel like – like, oh, now we're here. Now we're here. Like it was so quick that it didn't feel like – it didn't feel like it really taught anything. It was kind of cool – it was the cool aesthetic thing, with like being able to put the – we had fun putting like the planets and like screen shotting them. But there was also no camera button. Like I don't know if you could just take pictures of the planets or the sun.

But we screen-shotted it, but like – I don't know. It was fun, but again, I don't know if we'd go back and visit it again, because it didn't really feel like we learned – it was something that you could like teach or something. Like it would be – it'd be cool if I you could be like, we got to Mars, and it's like, here's the facts about Mars. You know, a little bit more in depth. Dean did a whole project on Mars for school last year, and it was so cool. Like he made a board game out of it.

He made his own board game. And it was interactive and fun, and something we can keep going back and playing different cards, different scenarios each time. And just trying to make it a little bit more unpredictable. Kind of like that's just – you know, just follow the map, you know.

Or like we said, make it a little bit like harder to reach. We really reached all the planets quick. Yeah. You just place the sun, and then you just get all of it. _____go out the window sometimes. Yeah, we're like, how do we go through the wall?

I mean, it was – it just didn't feel like we really got much out of it. It was fun, but like I wouldn't go back and play it, you know?

Interviewer:

That's really important feedback, because I have been – I've – other folks that I've talked with, I've been hearing that like, yeah, I did it one time, and it was cool when I did it, but I know if there's as much repeat. And I think that's okay.

Participant:

It's like – like he said, if it was like a real journey, like a longer journey, and like, hey, we're going to go walk – it'd be great to go on family walks to Mars, or family walks to Pluto. Like it'd be great. Like we're going to do it, and like set it up, and we could even – like if it had a time feature or something fun, like something to make it a little bit more special, where you would want to use it again.

You know? Or like, hey, like you're now – you're on your way to Mars, or like, you know, you – like maybe even have some like things – scenarios pop up or something happen that could happen on your space journey. Like just something pop up, saying, you know, you have to go around this asteroid belt, or you have to – just something fun. I don't know. Something

just more interactive.

And I wouldn't mind being out on a walk, and spin around, and try to get around asteroids, and having to – you know? Just something more fun. Or like even like we said, like a fact, like, hey, I just found out like this about Mercury on my way to Mercury, you know? Or something – like something that – it would pop up, and it might be something that could just be – that way, it's not predictable. So every time you go on this space walk, it might be a different experience.

Interviewer:

Yes. So let's dig in a little bit into the second kind of overall question is about interesting – like **how interesting was the information in the activity**, like what you were – what was being presented. Did it make you want to – curious about things? Want to learn more? Did you not – things you didn't know? So if you were going to say overall how interesting were the activities, and then we can dig into like specific ones that really stood out to you as being really interesting, or maybe not so interesting.

Participant:

I would say like they're interesting, but they don't really teach you anything.

Well, the space garden one did. Like we learned about like how you can grow without soil and stuff. But that's like the highest amount, and then the rest is like, oh, do this as a fun activity for a while. And then you're kind of done with it, so – and you don't really learn much.

Plus, there's like – oh, yeah. You do learn this about the planet while doing this. But you only learn one specific thing, and you're not going to really revisit it, and it doesn't teach you anything else. It only teaches you that one little thing.

Like the Mars Rover thing. It teaches you about the Mars Rover. But we also know – it's also – it wasn't really realistic, because it was like basic coding. The Mars Rover app.

We actually have gone to the _____ Museum and got to drive – test drive like the little model rovers there. And the instructions are opposite of what you actually program. So you had to like think in your brain how to actually program a real rover. It was a lot more complicated than just these simple like arrow directions. So I think this one was – I mean, you know, especially for a ten-year-old, and we've just pulled it up again, you can clearly see where the boulders are. He can count spaces. He's really good about being able to do multi-step directions.

Where different – when you have a lot of unknowns or maybe having some like – like again, oh, you ran into an issue here. Or you found – that was the other thing, because when he went to the one we got to – the Mars rover at the _____ Museum, it was – you found some life particles,

and it'd tell you what the particles were, and gave you a little bit more information on real life things that could be found on different places, in different – you know? That could possibly start life. And I think that was a lot more scientific learning activity than just being able to kind of code and figure out which way to send something, you know?

Interviewer: **Well, let's talk about the space garden, because you said there were some cool things that you learned about in there. What about that activity really stood out for that reason?**

Participant: Well, I mean, we're really – we're fortunate enough that our school – we've done this activity previously, so I didn't really think it was a new activity. When did you do it? What grade? Do you remember what grade level you did that? I mean, you did it early on in school. Do you remember what grade you grew the gardens and stuff in the windows? Was it first grade, maybe? I think it was first grade.

So he's done this like when he was seven, so it was a nice refresher to kind of do it again. But I think like – yeah, like it was not something new for him. So it wasn't as exciting. You know, maybe if I kind of like _____ it might be a different situation.

But it is so cool to see how you can start life and just give it some basic things of – you know, basic things it needs, and then see how it grows, and then kind of observe it and watch it. And we had plants in our windows for a while _____.

It's so cool to see the roots and stuff sprout and germinate, and then decide we want to transplant them or not, you know? It's kind of cool to see how that works.

Interviewer: **Yeah. On your survey, you'd mentioned that it was – it was fun to come back over time and check on it.**

Participant: Yeah. I mean, that's – I mean, I was – that is fun. It's so fun to come back and see like progress and growth. It's like, whoa. That's something that you can – it doesn't take a lot of time to come back to, but you do learn a lot from that activity. Where you can come back and see and like think of, well, you know, what do I have to do to keep supporting this life that we've created? Do we need to do anything? You know, because it's – and like – and just thinking about how that would be on another planet. Okay, if you wanted to keep growing, like you have the same conditions that you needed, but when do you have to switch the conditions? And that's the kind of things that it was really – it really brought that idea of space travel to life there. I think that was a really cool activity.

[Crosstalk]

Participant: Where it's just like – well, like some of the other ones are like, well, like you said, a one-off activity.

Interviewer: Yeah. And those are – it's okay for them to be some – I'm sure there are probably some kids out there, and it's totally fine, where they just want to keep doing that over and over and over again. So it's – there's a whole range of ways to use it, and part of the reason we're talking to people is to understand where that happens.

Participant: I think probably younger children would want to do it over and over and over again, where [CHILD] is more of like – if he – he likes to have some sort of challenge in order to make it – like something that's really easy for you already, and you can solve – it's like if you can solve the puzzle already, it's not something you're going to reach for.

Interviewer: **Was there anything that you remember – because what you wrote down was we were curious about things from the In and Out game. It made you curious about the places, and you wanted to look them up to know more of what was going on.**

Participant: Yeah. I thought that was a really fun one. And I feel like every time we've played that game – we've played it multiple times, because the questions are different. They switch. And sometimes you get something – it's funny, because we're like – I don't know, I think we were playing – I was playing – the first time we played it, it was like, one of us got like the super easy questions, and one of us got like – it seemed like it was stacked. It was like is Jupiter in our solar system? He's like, oh, yeah. Then I'd be like, what about this? Like I don't know what that is. You know? It was just really funny, because it just seemed like – it was a really fun – because it was the unpredictability of it, and it's not knowing what you're going to get asked, is really fun.

Participant: So like read about it, and like it tells – when you select an answer, it gives you further information. So you're not just like, hmm. But it also is something that we can wonder about and go back and look at. Again, like, hey, my – one of my – we love going to the Bell Museum with the planetarium, and whenever we go, we love to ask about questions, and they love to learn about everything. You know, they're obsessed with black holes, and obsessed with all the – just learning about all the planets. And so every time we can go and – we're actually going to the Science Museum later on today to see the panda movie.

But we do go see the space movie, too, you know? The deep sky movie? It's nice to kind of go back, and want to learn more about it. Like we learn about a place in the In and Out game, and like we wonder, okay, like Juneau, what is Juneau? And okay, here's a picture of it. Do we think that's here, or do we think that's – you know, things that could be somewhere

else, you know? Like it just is like – I don't think that could be way out in deep space. Just trying to figure out like –

[Crosstalk]

Yeah, like we know enough about – he knows enough about space to know like we're in this galaxy, and – that our galaxy has different types of – like the nebula that usually – so it was kind of like – like we could find some correlations and some patterns. Like, okay, we get these interesting nebulas. They're probably not here. But that was something that we learned about. Like I didn't even know those nebulas existed, you know?

Participant:

What else would you like to learn more about after playing with this app?

Participant:

It'd probably be like – I want to learn more about what – what is this nebula, where is this galaxy. Things like that. Yeah. I would like to – I played some of these things, like I was always wondering, like, you know, it would be great to have some sort of way to like try this space food. And I'm wondering about that kind of stuff. And learning about – just more about like how you could use some of these activities to – because they're almost like, you know – well, I was wondering what the extensions – like what else could we do to kind of like – what else could we grow without soil?

Or try something different. We tried one type of seed. Could we try something else? So some different extensions would be fun, to like just – how would that work? And like the – oh, God, the ice orbs. That was a – that was just like – it was like the hardest one for us. We had fun with it, but yeah, it was the – we made some key mistakes, messiness. He had a leprechaun-looking bathroom for a while, because I put the food coloring in the balloon, and then we tried to get it on, and it popped off, and it went everywhere in the whole bathroom. Not just one time. Multiple times. But it was operator error.

But it was just like – a lot of it is – that activity is fun. That's one you have to go back to. But we kept forgetting – because it was cold outside, but it was – it just never was cold enough. So we never did go in the freezer. So kept watching it. It was kind of fun. It was something we'd just check in on every day.

And then, of course, we'd come back, and then one day it snowed and froze, or rained and froze. Like, oh. So then we had this big solid block of ice. We had to like heat it up, and then try again, like get some – some of them were fine. But it was just – it was a lot of fun. We enjoyed doing it. That messy process actually makes it fun, when you're looking at – Yeah. We had so much fun.

And then actually – you know, of course, I don't know – ours never looked that pretty. Like the ones in the beautiful picture here, ours did not look that pretty. I don't know if like we needed to swirl it or what we needed to do more, like with the water. We used the freezer.

But the hard thing, you know, it doesn't say to do, like once you put it in there, like with the – and the directions, I don't think it tells you there. Yeah, it just – well, it says warm. One thing that would have – I don't think it ever tells you, or at least I didn't see this, to like maybe mix the balloon up a little bit or something. Because to get the color – it was all in one spot. It settled in one spot. The bottom of the balloon.

I think if we were doing it again, we would put it in, and then maybe like roll the balloon around a little bit, shake it a little bit, and swirl it, try to get a little more color throughout. Because I loved the one like – both the picture are so pretty, and ours is like mostly ice, with a little – the green in one spot. Ours was like the Jupiter great red spot. Except it was green.

Interviewer: That's a great connection, actually.

So speaking of that, kind of related to like what were you curious or wondering about, were how – what kind of connections did you make between these activities and things in your own life? Like how were these relevant – how is space exploration relevant to you, based on these activities?

Participant: Why is it a good thing for exploring space and stuff. To learn more about like our own home, basically. Not just earth, but where earth rests, and the galaxy _____.

Yeah. It's also nice to know like could be out there and what to look for, like, you know, we've gone and watched a lot of planetarium shows, like watching about like other planets and how like – or looking for like – hey, this previous, you know, existence of water here. That's kind of cool.

What does that – what else was there, or what else needs to be there? And it's amazing like to be able to – like we always keep thinking, like life on Mars is always – I think for kids, it's thinking of people or aliens, where literally life on Mars is little microbes and little microscopic organisms and things that are really hard to see. Like that's where life starts.

And I think that's a really good thing for them to kind of learn about and to understand, that not all life is large, complex human beings or big animals and mammals. So that's kind of cool. And then it's good to also think of like what's beyond the galaxy. And that's why I really like when the museum – because, you know, being a science museum, they don't really have a lot of big space stuff there, besides the giant space man. They really don't have a huge space focus at the Science Museum.

But I do love they bring in the IMAX shows that really do tie in. And they do like the Stellar _____ and – I always hit those things up, because my kids are super interested in space. So it's nice to bring those tie-ins in. And that's something we're always looking for, because we enjoy learning about it. But I think it would be kind of cool if they had – you know, it's hard, but, you know, a little bit more space focus. But it also nice that the Bell Museum is a different focus, it being – being able to like they have star parties every month, and you can go and look at telescopes, and like you learn about it and then actually get to try and see it. That's a different – that's a whole different ballgame. I think that just – it's different when it's a – you know, it's a game, it's an app, and it's – you know, it's a model, versus an actual like getting to see _____.

Interviewer:

What about the – so let's go back to the ice orbs and the space garden. What about those particular activities connect to your daily life? So if you're thinking like they're supposed to be teaching you about – something about human space exploration, how does what you were thinking about and learning about –

Participant:

Learning about how like the water and how like – you were learning how earth isn't the only ocean, place with oceans, and hearing that they exist beneath the surface on moons and planets. And that's really cool, and that's neat to know. And I didn't know there were so many different places in the solar system that had water. That's one thing I learned.

I liked the _____ in the ice orb, where it's here's the summary of the activity, and see if it's interesting. Then the detailed instructions are great. But then there's an explanation piece, too, that really ties in, and you can really then go and do more of a deep dive, which I think is cool.

It makes things a little bit more exciting and hands on, and it also then is like, wow, I never thought about like Europe and how I can look there and look and see if there's – like you learn about missions to different places. I didn't know some of this stuff was even going on. This is kind of like – I should know about that, right?

That seems like something I should know about, some of these missions that are going on, with – like looking at things, and seeing if you can – can you bring something there to check it out? When's that going to happen? When is NASA going to be able to explore some of these places? Can they send astronauts there one day? That's really kind of cool to think about.

And my little one always thinks about that, too. He goes, if I go to Mars, will I be back before – like when I would get back? And it's like, yeah, it's far away, and it's kind of hard to think of the distance of that, because there's nothing to help measure. Like when you talk about, yeah, it's this far away,

but that's kind of hard, until you can really grasp like how spaced out things are.

But I do love the explanations, and I do love how that is. I also love the hands – a lot of the activities being hands on, with materials – a lot of the materials, you do have at your house. It makes it fun to try and – you know, you learn by those errors. And I always talk, too, like, you know, yeah, we had some problems and operating errors with the ice orbs. Can you imagine if that actually happened – or like if we had some problems with growing food. What if that happened with your seeds up in space? Like you'd have to think of another way to fix this up, because you only have so much resource. So you have to figure out like what happens if I don't have that light source? Or what do I do? What do I have to find? You know? So it really kind of makes it interesting to think of like what to do next.

Interviewer: **I'm getting a sense that your household, there's already a lot of interest in space and space exploration. There's already a lot of knowledge about space. You know, there's – and there's a lot of excitement about learning.**

Participant: So we're very fortunate. We live in – we live really close – we're like 15 minutes away from the Science Museum. We're 15 minutes away from the zoo. We're 15 minutes away from the Children's Museum. We're 15 minutes away from a lot. You know? So we're very fortunate, because we have all these opportunities at our fingertips, and we use them. He went for school to the Science Museum for a field trip just last week. And I was shocked at how many of the kids have never been there, being fourth graders, and living close by. I was shocked. But we tend to do a lot. I mean, we've gone – we try to go out and go everywhere, art museums, everything. The Science Museum is at least two times a month for us, at least. Or more. When he was younger, we were there at least once a week, you know?

Interviewer: So I'm going to get in a little bit of the weeds here, but – so the reason – so this overall project has an onsite component that are just – they're facilitated activities, but some of them are very – are similar to what's in the app. And so that would be like a museum educator with materials sort of like doing some of these things. But as you had mentioned, there's a whole lot of families and households that either have never been, even if they live in our area, or across the country, because this is a nationally distributed project, that don't live anywhere near a museum where they could go and do these sorts of these things. And some science teachers aren't comfortable doing hands on science stuff.

So one of the motivations and why NASA wanted to fund this is so that anybody could go on Google Play – and we know not everybody has access to a smartphone, but more people have access to a phone than a museum. And so how do we make a platform that people can bring into their own homes and sort of open up this idea of the interest and the excitement around learning about space and human space exploration.

Participant:

It's a good start, but I think that in order for it to be something that people – like – because some of these are great activities, but then some of them are, as you said, I feel like they're one-off activities. It would be great to be able to go back and like see if you could beat your score on the Mars Rover _____. Could you do it in less moves? Just a little bit of things that make it more playable again. Not just like we did it, you know?

And it was fun. We had fun doing all the activities. And we had fun trying to hug the planets. You're like trying to like – like stick family pictures by these – it was entertaining. But I think for it to be a little bit more than – to have a little bit more playable activity than just have things a little bit more – yeah, just have a little bit more tweaks. So like you said, oh, you know, we know like the space missions, nothing ever goes seamlessly. You know?

Like what happens if you lost a piece, and then have to go back and circle back? And you hit a square, like, oh, you're delayed. You have to go a different route. So even though you know the path, you can't go that way. Making it – like you have to drill through a rock or something like that it's a little bit harder, to make it a little bit more like it's not just going to be I can see the clear path to the exit and get there, right? Like it's – the little garden mazes, the little – start to finish.

Yeah, because like this would be a lot more fun if you could like – or if there was like – you could take into account wind and stuff on these planets. Like if you're on Jupiter and you're having this great red spot, so you have to time it where you're not getting hit in that area, or you have to – like that – just something to make it a little bit more – or a little bit more special, I guess.

Because I feel like it's almost like you could play that on paper, you know? It's – you know? Where it's – you know, what makes it where I need to have an app for it, you know? What makes me want to have that on my phone to redo? It's a little bit more unpredictability of things.

Interviewer:

So that's another question I haven't asked yet, but what you've just said made me wonder. Does having those things on your phone, though, make it more accessible and more likely that you might try it out, versus like I have to go to a website, or like type in a URL, or print – you know, just sort of when we're thinking about like how do we get more people –

Participant:

Through ease of – for ease of use, an app is great, because you can play it anywhere. It is nice, like I could pull it out and hand it to my kids while we're waiting somewhere. Like, hey, try doing this. Like for my six-year-olds, they would play that Mars game over and over again, especially because like after you program it, it kind of goes to like this – I do love that it goes from that screen of like plotting it out to almost like a real life example, and you get to see what's going on. That is really cool. And that's what – like I said, it would be re-playable for a lot more kids if it was _____ predictability. Because I do love that – like I almost feel like you're transported to a real life place.

But if you just take – I mean, even if you have the option to take away – like for someone like him, who's older, take away the first screen of like the – this one, where you can plot it. And bring it right to the view where it's the real time view, and he has to play it real time view and try to judge that way. That would be a little bit more challenging for someone who's older. Because he's really good at programming, coding. He's had – we have like robot turtles and like all these coding games already in our house. So for us, it's like playing that. Like honestly, it's like playing robot turtles, where you have to map it out and try to figure out – but at least with that game, you're competing against each other for the element of unknown. That makes the game re-playable.

That's kind of what I think of like, you know, we reach for those kind of things because when you're playing – in my mind, when you're playing any sort of game or, you know – you want to have this am I going to win? Like a little bit of _____, you know. So I think for him, like having that – because I do love that view where it looks almost like a real time view from the Mars Rover. He would have a lot more challenge if it was just that view. Like having that option. But my six-year-olds would not be able to do it that way.

Interviewer:

So speaking of – it sounds like there's multiple people in your household who have used the app in different ways. Can you tell me a little bit more about how you use this as a household? Like you mentioned that sometimes your six-year-old will just sort of like play with the augmented reality stuff.

Participant:

They have a lot of fun helping out with some of the activities. Like they did the ice orbs with us, and they actually helped me with the solar – like plotting on the paper, the solar system. They enjoyed that part.

But yeah, I didn't – we didn't – I didn't really have them explore the games and stuff yet. But that'd be something I'd definitely be interested in getting them to try. I mainly did it with him because I know he was the one who was kind of testing it out from his point of view.

They liked that. They liked the space garden, too. He's got two six-year-old twins for brothers. But he – but they tend to be more re-playable. And like

even with videos, they're like – they play the same thing over and over again. We have one who's super interested in natural disasters, so he will play tornado videos over and over again. He's super into space, because of Jupiter and the great red spot, and he wants to know more about it.

And the other guy is like very interested in other types of things, like really like very _____ things, like maybe like – he's interested in like something over there, something over there, something over there. For them, it'd be a lot harder. I think the activities would be a lot more challenging, and that would make it for them more re-playable. For an older kid, though, I feel like it just needs to have some tweaks in order for it to be re-playable for them. And they're not going to really be on the phone that much. But they could have it on their tablets. They could have it on their tablets. That's a nice app –

Interviewer:

Yeah. So thinking about the activities – like the DIY activities, so just thinking about the things where you had to like follow steps and make stuff, was there anything that you did differently or modified from what the instructions were? This is just sort of like did you have to change anything? Were you curious? Did you try it differently –

We just sort of followed it as is. I mean, we put our – so we put ours outside to freeze, because it was cold enough to do that, for a little while. But we didn't use the freezer, because we didn't have the freezer space.

I do like that he could pick up the phone, have his bucket of materials, and do it himself. With a lot of those activities. Because he's at the age where he can read those directions, and the scientific things were not – like they were really well-written. They weren't over-extended in terms of like what do they mean by that? Right? There was nothing about that – like we didn't understand what the directions were. They were really clearly written, concise. They weren't like too simple, but they weren't too like vague. Just in the middle.

And I feel like an older kid could understand like, oh, this meant – like, oh, put like the baking powder in like the mold. Yeah. They gave us the freedom to do some modifications we wanted to. But I did like some of the hints, too, where it's like, oh, you don't need to put a whole bunch in there. You don't need to put a whole bunch of glitter in that. You don't need to put a whole bunch of food coloring in there.

Interviewer:

Did the doing – when you did the activities together, what kind of conversations were you having about the – about the activity or about what you were figuring out?

Participant:

It was nice to be able to like look at the material before we even started, and be like, I wonder what we're going to do with all this? Like just put it all on a tray and say, what are we doing, guys? You know, like kind of come

up with some guesses on like we're going to – like I think we're going to make water balloons, or – they're just trying to figure out what this is. Then we're going to freeze that? Okay. You know, and it was really kind of fun. Like what do you think it's going to look like in there?

You're the one who remembered about them. I'm the type of person who like – it's hard for me to like keep remembering about these activities days later. And he's like, we've got to check the ice orbs. We've got to check the garden. We've got to check – he's always been good about that, like being able to like remind us, like we've got to do this. We've got to do this. Which was really helpful.

But it was really fun. Like it was really – there was a lot of fun and excitement when we got the box, like the stuff in the mail. Like, what is all this stuff? Look at this cool flashlight. Look at this like – we were super excited to see all the stuff that we got to try. And I think that'd be kind of fun. Like that's a cool thing. I don't know if there's like – because for the app, you know, there really wasn't much that like I would say – I don't know if many people have a funnel at home, but it's not even necessarily needed, I guess.

For the long run. So it's just kind of like – I think that many people can do these things at home. I kind of – you think about COVID learning, like, yeah, we could do all this stuff at home. And we have so much stuff at home, but – I think most people have – yeah, you sure can.

So it's nice to like use up materials that you have like at home. So if you have like extra balloons and food coloring, you can do ice orbs. And then if you have like maybe a little bit of time on your hands, you can do a little more of it. And I do like – for a lot of it – I mean, most people have paper and crayons, basic materials. And they're fun activities for your children to do.

It is a lot of fun. And I do like then like being able to then look at it, like, okay, now we've got this done. That was fun. But what's like – what was it intended to do, right? Like say, okay, this is what we made a model of. We made a model of like an ocean world, or we made a model of, you know – being able to figure out what is in our model, and what does it look like, and – you know? Yeah. I think – like I said, like we figured out ourselves that – the ice orbs is something we'll probably have to go back and try again, to like try to get a better model.

And I think that's what scientists do, though. Like scientists go back, and they re-explore and fix it, and repeat things, and learn from their mistakes.

Yeah. I just think there's definitely some room for them to add in a little bit more facts or some like re-playability. Because that's – the planet walk could be so much fun if like – if they have it to scale, and they told me

what the scale was. Like it's one one-thousand millionth of, you know, of what actually it is. And like being able to – like just knowing like how far apart is Mercury to Venus versus Venus to Earth? Like what's the distance? Because on the app, it's all like pretty evenly spaced out.

Like Mercury for the planet walk. Like why not be able to like, oh – this distance is a lot farther. Like how far is it to get to Jupiter? Like man, Jupiter is far, far, far away. Like we had to walk a lot farther. And like – but – and then you could like as a family decide, like, hey, where are we going to walk today? Are we talking to Mars? Are we talking – you know, Uranus? You know? Where are we going?

I think overall, like I think – I think – like I said, the directions were really great. I liked the tips. I loved that they even had like a safety thing in there. I think that's important, especially when you're working with little kids and stuff.

And they're right. Like it does say like suitable – like the ages it's suitable for. But it'd just be nice if they had like different versions. So I think our main thing is just like – it was a lot of fun, but like for him, it's a little bit harder to go back and like redo it all, because he already knows a lot of it. You know, he's kind of my – always been my science brain guy, _____ explore things. But my little ones, a lot of it would be new to them.

Group B: One adult; One Child

Summary of Key Ideas:

- **Enjoyment and Interest:** Activities were described as very fun and somewhat interesting
 - Planet Walk: Enjoyed viewing planets in augmented reality, allowing them to see every surface, and placing planets in creative spots around the house. The scale of distances in space was surprising.
 - Pack Your Bags: Found it less immersive and low-tech, involving gathering items in a bag. Chose minimal items, which affected enjoyment.
 - Mars Rover Game: Found it fun but suggested improvements for better navigation accuracy.
- **Curiosity and Learning:** Wondered how the International Space Station was constructed. "In or Out" game prompted curiosity about various places and phenomena. Learned about the vast distances between gas planets from the Planet Walk activity. Recognized different spacesuits are needed for various tasks in space. Understood the process of air filtration in spacecraft through the Breath of Fresh Air activity. Gained knowledge about space exploration, planetary distances, and life support systems in space. Prompted to look up more information about space-related topics after the interview.
- **Connections to Daily Life:** Recognized the relevance of needing different clothes for different environments, similar to spacesuits. Identified the necessity of breathing and air filtration processes as connected to their life on Earth.
- **Family Involvement:** Activities were done both individually and with siblings, especially the Planet Walk. Younger siblings showed less interest, while older siblings were more engaged.
- **Perception of Self as a Science Person:** Did not initially consider themselves a science person but acknowledged past interest in birds and drawing them. Activities somewhat reinforced their sense of being a science person.

Interviewer: I'm going to ask you two big picture questions. So, thinking about all of the things that you did, overall how fun were the activities? Would you say they were not at all fun, only a little, kind of, or very?

Participant: Very fun.

Interviewer: They were very fun. I'm glad to hear that. Now, how would you say – and sometimes I know these words are maybe tricky to differentiate – how interesting were they? Because something could be fun but it's not that interesting, or it could be really fun and really interesting.

Participant: Well, I think they were sort of interesting.

Interviewer: Okay. So, now I'm going to sort of ask you to think about the things that you did individually and I'm going to ask you to talk about what did you like about them? Why were they interesting or not? So, for the activity called "Breath of fresh air" where you changed the color of the water, what did you like about that one? What was fun or not fun? What was enjoyable about doing that activity?

Participant: Well, I can't really remember what I did because it was so long ago, because we got the activity things a month ago. So – but –

Interviewer: What stood out to you about it? What stands out now in your memory? That's okay. We can come back to it. What about – do you remember it being interesting even if you don't remember specifically what was interesting? Do you think that it – was it fun to do?

Participant: Yeah.

Interviewer: It was fun? Were you able to make the colors change back?

Participant: I think I made them change back mostly.

Interviewer: Mostly. Did you – did you – do you – did you get to talk about what was going on? Or was it just sort of like "Oh, wow, that's cool"? Did you have questions about why that happened?

Participant: I can't – yeah, I can't really remember this.

Interviewer: Okay. No worries. No worries. So, of the activities that you did – let's take a different approach, then – which one do you remember the most?

Participant: Planet walk.

Interviewer: Planet walk. So, let's talk about that one. What was fun about that? What did you really like about that?

Participant: It was just really cool to have there be, like, the planets floating around in the house.

Interviewer: What sorts of things did you do when you had the planets in the house?

Participant: Like... it's cool to just be able to see every surface of it. In the pictures it's just bleah. And then, maybe in the videos it's just "Ah..." But with that you can actually look under it and look over it.

Interviewer: So, what I'm hearing you say is that it was really cool because you – rather than looking at in a book where it's just flat and you could only see the one side, you could – it's almost like you're in space looking at it, like "This is

maybe what an astronaut would see," and if they fly under the planet or if they go and orbit around it, that it's just not what you were expecting.

Did you put it anywhere funny, like "Hey, look, the moon's on my ceiling" or "I put Jupiter in my bathtub"? Did you – or did you just sort of sit in one – sit somewhere and just sort of have it in your living room?

Participant: I think one time I put the sun in a fruit bowl. And also, I think I put Makemake above one of my Lego sets.

Interviewer: Was that to make a scene, like the – like something was going on there? Or that's just where you decided to put it?

Participant: I think it's just where I decided to put it.

Interviewer: Okay. Did you use it by yourself or do you have – do you have other siblings?

Participant: Yeah. Well, one time – since really the only way to see the entire solar system is to go on a really long walk outside, we went on a walk and it was cool. It was like – inside I was thinking "Okay, how do I unlock the gas planets or the asteroid belt?" because I didn't really understand how it worked because it was just like "[inaudible] or the terrestrial planets."

Interviewer: So, yeah, that's – that is – yeah, that's kind of cool how with the – when you take it outside you can see just how big everything is. And that's even still scaled down. But yeah, that you could kind of get a sense of how – what the solar system, how it's laid out, how close and how far and where things go.

Participant: Also, if I went to the end of the solar system I couldn't see all the planets because then it wouldn't render. We could only see the one that we had just unlocked or something like that.

Interviewer: Oh, does it – so, if you go all the way to the end you can't turn and look all the way back to the sun and see all of the other planets? You can only see one at a time?

Participant: Yeah. When they're closer together, with terrestrial planets and the sun close together, you can see all the ones. But then, once you get to after the asteroid belt it's a lot harder because the gas planets are spaced much farther out.

Interviewer: **That is true. Did you learn that from the app or is that just something that you knew already?**

Participant: Well, I didn't think the gas planets were spaced so far apart.

Interviewer: Okay. That's cool. Yeah. Sometimes it's really hard to think about how far away and how far apart some things are. But I'm glad that you had fun with that activity. I know the people who built it put a lot of work into making it fun and I'm always – we're really curious to know all the different ways that people use it.

So, I'm also going to – so, the one that you said was not enjoyable was the "Pack your bags." So, that's where you had to put things in a paper bag. Do you remember doing that one? Do you remember what stood out for why that wasn't quite as fun as the other ones?

Participant: It just wasn't very immersive. It's just like "Oh, go around the house, find some toys and pictures and stuff and put them in a lunch bag."

Interviewer: Ah. Did you – so, I think – you're very right. It is not very immersive. It is very low-tech. Did you have a conversation with any of your siblings or your grownups about what you chose and why? Because I know I would have a hard time making a decision if that's all I could take with me on a long, long trip. I mean, I have a hard time deciding what I want to take when I go camping for a weekend.

Participant: Well, actually, for the "Pack your bags" I don't think – it might not have been as fun for me because I didn't put very much stuff into my bag. There was a book and two little Lego figures.

Interviewer: Why did you choose those?

Participant: To read and also I like to play Legos.

Interviewer: So, those sounded like some fun things to have if you were going on a long trip?

Participant: Yeah. But now that I think about it I'd probably want to bring something more than that bag.

Also, when it was asking what they would need for the "Pack your bags" if they were on expeditions to Mars, I wasn't really sure because I knew that if it's a longer expedition they would probably need more things. But more things means it's probably heavier, and in a long expedition it should probably be lighter. So...

Interviewer: Yeah. Although when you think about an expedition, –if I think about it on Earth, yeah, usually you're backpacking and carrying things. But if you're taking a long expedition you're probably – they're probably taking a space shuttle, so most of that stuff gets carried. But you're right, that is – those are definite considerations, that if you've got to bring everything with you, you're responsible for it.

The last specific one that I wanted to talk a little bit about was the Mars rover game. What do you remember about that one? So, you had the little icon, the little Mars rover and you had to tell it to go up to and to the left one and down to avoid the rocks. How did you feel about that one?

Participant: I think it's pretty fun. But I think it might be able to be improved if when you place the arrow it would have a square highlighted where the rover is going, because I know that sometimes just looking at it you can make mistakes and be like – when you're going six you're actually only supposed to go five.

Interviewer: Were you able to get to the end?

Participant: Yeah?

Interviewer: Did you play it once? More than once? A lot?

Participant: More than once but I don't think a lot.

Interviewer: Not a lot. You figured it out and you did it a couple of times. Did you – what would you say was the thing that you remember most? What did you learn from it? Or what did it make you wonder? And it's okay if there's nothing. Sometimes it's just fun.

Participant: I think it's just fun.

Interviewer: Okay. So, that's actually going to move me into a question and what was in the survey – I'll let you know what was there. And then, I'm going to ask you to talk a little bit more about it if you can, and if not, that's fine.

So, in the survey it says that you mentioned learning about different spacesuits that people wear. Do you remember learning about that, using – and I'm guessing that's the moon suit piece?

Participant: Yeah. I think the spacesuits, something.

Interviewer: Yeah. What did – what did you learn about the different spacesuits? Or just that there are different ones?

Participant: I think probably just astronauts need different spacesuits for different things and, yeah, that there are different ones.

Interviewer: Okay. And then, also, you also mentioned – you're doing great. You are doing such a fantastic job.

I know it's hard to have a long conversation with a grownup sometimes. It says you also learned about what happens to the air you breathe out in a

spacecraft. Do you remember what happens? What did you learn about there?

Participant: Well, I can't really remember that.

Interviewer: Oh. Well, so, you remember – I'm thinking that's connected to the "Breath of fresh air" activity – is that when you blow into the water with the highlighter the color goes away because you know when you breathe in oxygen you breathe out carbon dioxide, right?

Participant: Mm hmm.

Interviewer: And so, when you get the carbon dioxide in the water it changes the color because it's kind of acidic. You know how soda pop is kind of bite-y, it feels kind of stinging sometimes with the bubbles? That's the carbon dioxide in it.

And that's actually the same thing that happens with acid rain. There's too much carbon dioxide. But that's a story for another day.

But then – so, when people are on the space station, when they breathe out they're breathing out carbon dioxide. So, then the filters that use that funny little rock, the zeolite, the zeolite grabs all of that carbon so then there's just oxygen left over. Does that remind you a bit about that activity? Because then, when you put the zeolite in the color came back in the fluid.

Participant: Mm hmm.

Interviewer: So, let's see. What about – can you think about or tell me about any of the pieces or the ways that the app activities were – that you did them that made it easy to learn things? Any parts of it? Any ways that it was – that made it easy or interesting to learn?

Participant: I don't really know.

Interviewer: **Okay. Here's another question. Can you – did you have any curiosity after doing any of those activities or playing with any of the games, did it make you wonder about anything?**

Participant: Mm hmm.

Interviewer: What sorts of things were you wondering about?

Participant: Well, I think I put this in the survey, that I was thinking how did they get the International Space Station into space?

Interviewer: Was that one when you were thinking about – which activity made you think about that?

Participant: I don't really know.

Interviewer: Okay. So, you were just thinking about humans in space because that's what the whole – all of the activities were about?

Participant: I think so.

Interviewer: **Okay. So, did you do anything with that wondering? Did you go look anything up? Did you ask a parent? Ask a teacher?**

Participant: No.

Interviewer: Okay.

Participant: But now that you say that, I'm thinking probably after this call I'll look it up.

Interviewer: Okay. Yeah. Sometimes we have a wondering and it just sits in our brain for a while and then it pops out later because you're like "Oh, yeah, that was like this other thing." You also said that in the "In or out" game you were curious about the other places that it was talking about and that you wanted to look them up to know more where it was compared to the Earth. Does that sound familiar?

Do you remember which one specifically? Or was it the other planets in the solar system? Or was it planets outside the solar system?

Participant: I think I just – I don't really get what you're saying. But I think I...

Interviewer: You're doing great. It's fine. I'm asking really hard questions. So, I think one of the last couple of things I want to talk about is – so, on your survey you said that – of course these all connect to human space exploration. That's really obvious. We did a good job there.

Then, when we said – we asked you, "Do you see how these activities and this information connects to you and your life on Earth?" And you said, "Not a lot." What were – do you remember sort of thinking about that at all? Can you think of any ways that the "Breath of fresh air" or the spacesuit selfie or the planet walk kind of connect to your everyday life?

Participant: Now that I think about it I'm pretty sure I said on the survey that I connected to "Breath of fresh air" because I need to breathe. But as far as spacesuits I'm thinking we need to wear different clothes in different – like, if it's really hot out you wear short sleeves and if it's really cold out you have to wear a coat.

Interviewer: Excellent. Yeah, that's a great connection. And then, my... let's see. I'm trying to pick the questions that I think are going to be fun to talk about. So, do you think – do you consider yourself or think of yourself as a science person?

Participant: Not really. No.

Interviewer: Okay.

Participant: Sort of. Like... when I was real – when I was younger I was really into birds. I would wake up really early in the morning and just get out my bird book and draw pictures of birds and hang them on the wall.

Interviewer: Oh, that's a wonderful – yeah, that's definitely being a science person. Did you – after sort of playing the games and trying out some of the activities, did that make you feel like a science person? Maybe in a different way?

Participant: Sort of.

Interviewer: Sort of. Was there anything specific or any parts of it that sort of stood out that helped you with that? And it's okay if you don't remember.

Participant: I don't remember.

Interviewer: Okay. Would you say that you knew a lot about a space – sorry – that you knew a lot about space exploration beforehand?

Participant: Not really.

Interviewer: Not really. But do you think – do you feel like you learned some things? I heard you say some things that you learned. You learned about how far away the gas giants were and the asteroid belt. And you learned about the spacesuits.

And you learned about the – how things happen on the space station with oxygen and air filters. And you made some connections and learned about long Mars expeditions. And so, I think – I heard you say a lot of things that you learned. So, you probably know a little bit more about space exploration than you did before.

And I think my very, very last question before we wrap up is can you talk – just tell me about how you did the activities? Did you do it as a whole group with your brothers and – brother or sisters? I don't – actually don't know if you have brothers or sisters. But did you do it all as a group? Was it just you and your mom? How did those work out?

Participant: First I did some things. And then, of course my – the – two of – my other siblings, since they're – I have four other siblings, two girls and two boys,

and then there's one girl and one boy that are older, one girl and one boy that are younger. So, the younger ones didn't really have an interest in that. But then, of course when the older ones saw it they were like "Why does he get to do that? I want to try that."

Interviewer: Did they end up trying it along with you or did they do it on their own?

Participant: Well, of course when we went outside to do the planet walk all my family except for my dad, because he was at work, did it.

Interviewer: Did any of the – did any of your other siblings try any of the games? Or – did you play the "In and out" game just by yourself or did you play with anyone, like challenge each other?

Participant: I think I did the "In and out" game mostly by myself. But I think my siblings mostly did the planet walk.

Interviewer: Did any of them try the Mars rover or the spacesuit selfie?

Participant: I can't remember

Interviewer: You can't remember. Okay. It's okay if they didn't. We're just one of the – we know that these activities were designed for people who were, like, 10, 11, 12, 13. And maybe a little younger. But we also know, like you, some people have older siblings and some people have younger siblings and they might want to do them all together. So, we were – we're kind of curious on were older kids interested in them? And it sounds like they were. And maybe some of your younger siblings were too young to do it, to recognize that they want to play along. But yeah, I was just curious on kind of hearing how everything went.

Those were all the questions that I have for you right now. I might send your mom a couple of follow-up questions, some things that maybe she has a little more insight on. But do you have any questions for me or anything else that you want to share that I didn't ask about?

Group C: One adult; Two children

Summary of Key Ideas

- **Overall Experience:** Enjoyed some activities more than others, feeling they reinforced existing knowledge and suggested tailoring activities to different age groups and levels of prior knowledge.
- **Relevance to Daily Life:** Talked about seeing a connection with the salt on ice part of the Ice Orbs activity to real-life use during Minnesota winters.
- **Prior Knowledge about Space:** Group had prior knowledge of space exploration from school and Science Center visits. Enjoyed the app because she was about to continue learning about space missions and had a particular interest in Mars.
- **Specific Activity Feedback:**
 - **Ice Orb:** This group enjoyed the activity, but had concerns about how to safely dispose of glitter to keep it out of the water system and discussed the ways salt interacted with the ice.
 - **Pack Your Bags:** Participants pretended to pack for a space journey, which was fun.
 - **Solar System Trek:** Found this to be less engaging due to repetition and the basic information was already known to participants.
 - **Space Garden:** Appreciated straightforward instructions and found it fun watching plants grow. Suggested including more details on when to transplant seedlings and identifying the types of seeds. Noted as most relevant to daily life due to interest in gardening.
 - **Moon Suit Selfie:** Participants enjoyed seeing themselves in a moon suit and found the instructions simple. They appreciated detailed explanations about different suits and said they learned about different astronaut suits for various purposes, which was new and interesting information.
 - **Code a Mars Rover:** Especially enjoyed coding elements and the excitement of maneuvering the rover around obstacles. Found the activity challenging but rewarding, with a participant expressing a strong interest in coding.
 - **Planet Walk:** Described this experience as visually interesting but initially confusing regarding what to do.
 - **In or Out game:** Understood this to be a test, not a game. Suggested providing information before testing for better preparedness.

Interviewer: All right. So let's see. Okay. And then for Ice Orb, you guys said it was super enjoyable. What did you guys like about it?

Participant: I think _____ freeze _____ make it with food coloring.

Interviewer: Mm-hmm.

Participant: You liked the different colors?

Participant: _____ even though the _____ wasn't great. We ended up using tongs, because the ice was really _____.

Interviewer: Mm-hmm. Okay. That's a good idea.

Participant: And also, it froze faster than two days. It took like one day to freeze.

Interviewer: Oh, okay. You guys have a super powerful freezer.

Participant: So it went quicker than we anticipated. You liked using the colors, the food coloring, and the glitter. So it was fun to _____ to see what would happen. Yeah, we only added a little bit, and it didn't really spread out very much. We had leftover glitter that in hindsight we probably should have just put it all in. _____.

Interviewer: Okay. What color glitter did you guys have? Do you remember?

Participant: It was the kind that you sent us, so it was like little silver chips, kind of.

Interviewer: I have a bunch of different colors. I was just excited to know what color you guys got. Everyone gets a different color.

Participant: We got silver, and actually, one of the pieces of feedback that we had was disposing of glitter, because there is a project at school – _____ Vivian. _____ project, and glitter _____ when you like wash your hands and you have glitter on your hands, it goes into the sewer system, and then because it's so small, it keeps going in, and then it gets dumped into the ocean, and then a bunch of fish _____.

So maybe some proper disposal instructions for glitter to make sure that it goes down the sink and into sewers and _____ melting as you're putting it together, so that the glitter doesn't become a pollution _____, right?

Interviewer: Okay. That was a really good – that's a really good – you know, I was kind of wondering what was going to happen with the glitter when everyone was done. That's a really good piece of feedback. Thank you. And then I'm just also taking notes as we go.

***Participant:* All right. And then we had the Pack Your Bags activity, and you guys said it was a little enjoyable. So why – what were we thinking about that activity?**

Participant: Hmm. I'd say you've got to pretend that you were going into space. And it was fun to pretend you were going into space? _____ that was _____ friend _____ friend together, and they _____ a lot of different

things. They got their sunscreen out from under the sink, because you need sunscreen.

Interviewer: **All right. Okay. And then we got the – we had the Solar System Trek activity. I think that was the activity with like the paper and the coloring, I think.**

Participant: Yeah. We decided that one was _____ now, and she had _____ before, so that one was not as interesting. Yeah. It was drawing circles on a piece of paper. So maybe for younger audiences, but for you, that was a little bit too basic?

Interviewer: I can see that being a little repetitive.

Participant: Yeah. You did know all that already.

Interviewer: All right. Do you remember any of the facts?

Participant: Something like _____ solar system is in between something and something else.

Interviewer: That's pretty close.

Interviewer: **All right. And then we have one that I think you guys liked a lot, the Space Garden activity. You guys said it was very enjoyable. What's up with that one?**

Participant: I liked how you got to grow little plants, and how it actually works. Mm-hmm. And it was kind of cool to watch the plants grow and change. And also, maybe you could recommend like when it is time to plant them in the other soil, because that was a little – like when do we plant this _____?

Yeah, so we liked that it was straightforward to do. The instructions were good. We had all the materials. It worked really well.

And I just happened to do a really similar thing _____ school. Yeah, _____ similar – we had more, but _____ we put that together, and then it started to grow right away, which is pretty fun, right? We didn't have to wait a long time. *[Inaudible]* and then _____ after a couple of days, clearly, we could see that they had sprouted, and the instructions said to, you know, put it into soil, but it didn't really give you any more details about when to transfer, how many days later, or _____ the various parts of the plant grow. We did _____ pretty _____, clearly. But that would be one piece of advice.

We also weren't sure what they were, so I think you were given three different _____. I don't think they told us *[inaudible]*. _____ seeds, but we weren't – lettuce and something else and something else.

So there was mystery plants that we had [inaudible]. And so they all – I think all of the seeds worked, germinated, so that was good. We had – out of the first four we did, one was really slow, and we didn't think he was going to make it, but he did. We wait to plant that one until – No, I think we planted all four of those together.

And then we had extra seeds that we didn't do the hydroponic version. So when we planted _____, we just _____ soil, and they all seem to have done pretty well, too. So that was fun to watch, because it also has gone on for a while, so it's – you know, it's a multi-week activity.

Interviewer: I'm glad that there's an activity that extends beyond the DIY part. That's fun. I also thought maybe it is important to tell people what kind of seeds those are. That never crossed my mind.

Participant: Well, you gave the options that it – we weren't sure which one exactly.

Interviewer: **All right. And then I think these are the – we're going on to like the AR activities that were also part of it. So the Moon Suit activity was also enjoyable. What did you guys think about that?**

Participant: I thought it was cool that you got to see yourself in a moon suit. And you got to do different ones and see what they were. That was cool. And the instructions were pretty simple. And at first, I was a little confused in the _____ realistic. And then we read the actual things _____ spacesuit was like a white _____. The _____ even better than the one at the Science Museum. Do you remember why you said that? Remember how there's that science suit _____ _____?

You've done that one a bunch. So anyway, this was _____ popular _____.

It had a good explanation about the three different suits, so she remembered what each of the suits was used for, and she could send that to family _____. So it was a good level of information.

Interviewer: **All right. Awesome. I'm glad you guys were able to like share facts and share pictures of the suit. That was probably super fun. All right. We have Code a Mars Rover. What did you guys think of that one?**

Participant: I thought it was really fun, because you got to do coding. And you got to move the Rover, and see what it was. And it was kind of _____. And it was kind of cool when they _____ because there was about to be a rock, and it looked like you were going to run into the rock, but then you suddenly turned. It was dramatic. It was exciting.

Participant: And then you turned, if you did it correctly.

Participant: I'm not sure the first time I did it _____ the Rover _____ the Rover was supposed to go.

Participant: Yep. So it wasn't too obvious and too easy, because the first time _____.

Participant: You had to persist and try again, and you got it right, and then after that _____ you had it figured out, and you did them all.

***Interviewer:* Do you ever think you'd do coding in the future?**

Participant: I already do coding, and I love it.

Interviewer: Oh, awesome. I also do coding.

Participant: I do it at school, and I enjoy it.

Participant: Yeah, you do like it.

***Interviewer:* That's so fun. Okay. And – okay. And the next activity, we've got Planet Walk. What did you guys think of that one?**

Participant: Was that the one, Planet Walk, where you'd like walked around the house, and _____?

Interviewer: I think so.

Participant: I thought it was cool that you got to see what planets kind of, sort of looked like. And it wasn't that _____ what you were supposed to do at first. _____ what to do instead of _____ sitting – or not knowing what to do. And also, I remember the first time I did it, I placed more – I placed like – I placed one planet on top of another planet, because I stayed in the same place when I placed them. So –

Participant: Did we make eclipse? Did we figure out _____?

***Interviewer:* So in the survey, you guys also mentioned that you learned about how ice – how salt helps melt ice, and a lot about astronaut space suits. You guys want to elaborate on that?**

Participant: So we used salt _____. So when we put the salt on it, and it was really cool, because one, it started melting really fast, and also, the _____ the salt were, it looked like cool little _____. Now there's suddenly a line of water there. It was very clear where the salt was, and it made a nice design almost on the ice, where it started melting, going down into channels.

That was pretty neat. Unexpected. We did not expect that. I kind of knew that salt would help it melt faster, but we didn't know how it would look. Like I thought it would do what the salt on the snow does, and then just –

Interviewer: All right. And then was that – did you guys do that in the ice orb activity?

Participant: Yes.

Interviewer: **Cool. Okay. And then learning about different astronaut suits, that was during the trying on the different suits? You guys learned about what the suits do?**

Participant: Yes. I _____ I saw which suits _____ for different types of them. So I thought they just wore one suit for every single thing. But there's like a space walk, one for flying and landing, one for Mars.

Interviewer: **Did you have a favorite?**

Participant: I think – I didn't want to choose, but I thought that this one was very cool.

Participant: That's the Mars Rover one?

Interviewer: That one is really cool.

Interviewer: **Okay. And then when you got – looking at you guys' survey answers, you also did mark that you guys didn't have any questions or wonderings about the activities. _____ like real questions about the activities? Everything was kind of answered while you guys were doing it, yeah?**

Participant: I think so.

Participant: We haven't necessarily talked about the In and Out. It was like a little quiz.

Participant: I think that they shouldn't quiz you on what you already knew. They should like tell you a bit of information about stuff before they just test you on it.

Because when we have tests in school, they give us some information about that, and then like we think about it, and then you do the _____. And, I mean, _____ some stuff about that, but I did really bad in _____ because I didn't know anything. Yeah, we didn't have any pre-reading before we answered the questions.

Interviewer: **That's a – that's a good point, some good feedback. And then of all the activities you guys did, were any of them relevant to like your day to day life? Did you find yourself connecting them to personal experiences or anything else?**

Participant: The space garden one was the closest to our normal life, because Mom does a lot of gardening, and we have the garden out there, and I do

gardening at school. And I like gardens and flowers and food, and planting stuff, and seeing stuff grow, and _____. So I think that one was _____. I think space garden was most relevant.

Participant: Yeah, I would agree. I _____ relevant. Well, you gave an example about ice in the real world. So when you were talking about putting the salt on the ice orb, and how it melted it, why do you put salt on ice outside these days? *[Inaudible]* ice and snow on the sidewalk, right?

Participant: When we're walking. Exactly. So that's kind of relevant to Minnesota winters.

Interviewer: **Most definitely. So _____. Okay. And what's your favorite thing in you guys' garden?**

Participant: Like in our garden at home _____?

Interviewer: Yeah.

Participant: I like – I like the food that we grow, the tomatoes *[inaudible]*, because Mom didn't know how to move stuff properly.

Participant: We _____ tomatoes, but we had a lot of tomatoes growing. Yep.

Participant: _____ like seeing how different things _____ like grow _____.

Participant: The sunflowers are pretty cool.

Participant: And also like learning that Mom, she would take the flowers, and then remove the seeds from that flower, so she wouldn't have to buy new flowers.

Interviewer: Oh, cool.

Participant: Yeah, we gathered some _____ the little flowers, we had better luck than the big sunflowers _____ some seeds.

Interviewer: Awesome. That's so fun. Now you guys can add radishes to your garden. And then before you guys had done any of like the space DIY activities, had you guys ever talked about space exploration or NASA or the moon or anything like that?

Participant: Yes.

Interviewer: Oh, really?

Participant: I learned a lot about it in school, and sometimes we talked about it at home. I talk to my mom about _____. So I learned about – yeah.

Participant: I think you had done a little bit of a space module at school.

Participant: It was in one at school. And we've been to the Science Center a lot, so we've seen the guys in space suits _____. And we talk about it a little bit, and she asked about the Challenger explosion a while ago, so we talked about that. Did we see any IMAX films at the Science Center about asteroid hunters.

Participant: You thought it was boring. Exactly. So we've seen a couple of IMAX movies at the Science Center about space.

Interviewer: Cool. Did you – did you have a – okay. What's your favorite thing to learn about space?

Participant: The people that were on the space _____, on the rocket, and the people that helped launch it, so everybody involved, the whole team. So maybe a little bit more about the individual people who went up?

Participant: Okay. What's your favorite planet to learn about?

Participant: Mars.

Participant: Mars. There you go.

Interviewer: That's a good one.

Participant: That's because of the book.

Participant: Because of the book?

Participant: *The Lion of Mars.*

Participant: Oh, *The Lion of Mars* is a book that we read. So yes, a particular interest in Mars.

Interviewer: That's fun. I also like Mars.

Participant: _____ kind of _____ stories _____.

Participant: Based on some reality, or based on kind of _____. Yeah.

Interviewer: **Am I interested in space exploration, knowledgeable, excited, and do I consider myself a science person? It looks like for all of them you guys kind of stayed the same. Can you tell me more about why you guys think it may have not changed?**

Participant: I didn't learn _____ new stuff, but I think it was mostly because I knew most of the stuff earlier on, so I didn't find it _____, and I knew some of the things [*inaudible*] and other things _____ about. And _____ already about _____. I did a report at school about Venus and Mars _____ and one of the _____ is that there might be an ocean on Venus. So they were going to _____.

Participant: Yeah, I think _____. I think you're exactly right. You knew a lot going in, and had a reasonable interest in, so I think this reinforced a lot of her knowledge, some fun activities that were interesting to do, a few new pieces of knowledge _____ that we didn't know _____. But I think she already was kind of a science person to begin with.

Interviewer: That makes sense. I can see it. You can always tell when someone's really into science. Do you think there's anything about any of the activities that may have – that would have changed how you thought about science and space exploration after? Maybe if they were more informative, went into more depth, or anything like that? What do you guys think?

Participant: I think maybe if they had a bit more detail about some things, like maybe – If you could _____ like – it kind of has this _____ like there's a level one reading that has some more basic information, and _____ and I know _____ more information _____ bit harder [*inaudible*] a little bit hard to read, and has a lot of information.

Participant: Yeah. And I think she was on the higher end of the age bracket, anyway. But yeah, I think more new stuff for you is always fun.

Interviewer: That's a really good idea. That would have been really cool.

Participant: Or where to go maybe to find more information _____ would have been _____.

Interviewer: Okay. And then I also wanted to know if you guys used the DIY app in any way other than we asked you to use it? Like did you do anything differently? This is a weird question. I'm sorry. Wait a minute. It's weirdly worded. Did you do anything differently than the app said, or make any changes to make – oh. Well, that's – okay. Did you guys use the app in any other way besides maybe the couple of activities that you guys did?

Participant: No. I think we pretty much...Well, Pack Your Bags, we kind of pretended that were going into space [*inaudible*]. We modified the rules – not the rules, but you modified the game a little bit _____. I think the app, we kind of walked through it, you picked out some at the beginning that you liked to try for fun, and then we read through the instructions to see what it asked you to do different _____. So I think we followed the list fairly closely, but we kind of explored the app first before we did the projects.

Interviewer: Okay. And then besides the Pack Your Bags activity, did you guys do any like further experimentation with any of the activities?

Participant: *[Inaudible]* we were going to do them again and – _____ was boring, because we had to wait so long _____. We'd already done it once, so we just did another – another version _____. The astronaut _____.

Participant: I don't think I had the instructions with me, and I might have gotten this wrong, but _____ with the space garden one, they had food coloring in the _____, too.

Interviewer: I read that over, because I like extensively looked over the app before I sent anything out to anybody, and I was trying to figure out where food coloring came in, and it didn't. So I just didn't bother.

Participant: So my question is why was there food coloring mentioned for space garden? We used it for the ice orb. That was great. But I wasn't sure if I was missing something there.

***Interviewer:* How did you guys do the activities? Did you do them all at once? Did you do them over the course of a week or two?**

Participant: I think we did them over the course of a week or two. _____ I didn't even _____.

Participant: Yeah. Probably over a week. We didn't do them all at once. We spread them out. Some were – we did probably the online stuff, like the Mars Rover and those kinds of things, we sat in the _____ one day, and you did – did the ones virtually. And then I think Ice Orb we did on its own, and then Space Garden we did on its own.

Interviewer: Okay. We kind of expect people to do them over the course of like a week. It's kind of hard to sit down and just bang out activities, because then they feel like homework, and they're not fun. And we wanted you to feel like you're enjoying the activities.

***Interviewer:* Based on you guys' response in the survey, you said it was just you guys, but then you mentioned a third friend. Who all did the activities?**

Participant: So it was me and Mom. My friend didn't really do them _____ do you want to play this little game with me _____? We had been doing this project, and she was here after school one day, so she helped us _____ you guys were having fun together.

***Interviewer:* You guys were awesome to talk to. Did you guys have any like last thoughts, any last minute feedback, anything like that?**

Participant: I think we covered it. Yeah, some of them were really fun, some were sort of fun. She knew a lot already. Maybe younger audiences would be different, but – we enjoyed – we enjoyed a couple of _____.

Participant: I have a recommendation. Maybe some activities that are kind of basic information, you could like recommend it for ages like _____ something that wouldn't already know this from school.

Interviewer: That is a good recommendation. I like that.

Participant: Or like if there's some that would be kind of too complicated for kindergarteners to understand, like _____.

Group D: One adult: Two Children

Summary of Key Ideas

- **Learning and Knowledge:** Learned about the limited personal items astronauts can bring and various astronaut suits, and sparked an interest in learning about other planets and elemental science. Noted that the activities reinforced and expanded their existing knowledge about space.
- **Overall Experience:** Some activities were more enjoyable than others, and suggest clearer age recommendations and consideration of the difficulty level for younger children.
- **Relevance to Daily Life:** Information in the activities related to school modules and personal interests. Also made a connection to videos seen on YouTube.
- **Specific Activity reflections:**
 - **Breath of Fresh Air:** Was enjoyable for its experimental aspect, but ended up being kind of “meh” because of issue with dried-out highlighter affecting the activity. Appreciated the follow up explanations and found that beneficial.
 - **Space Medallion:** Likes the opportunity to be creative and freedom to explore own designs. Both children created rocket ship designs.
 - **Pack Your Bags:** Remarked on gaining insight about the limited personal belongings astronauts can take and noted some challenges in deciding what to pack.
 - **In and Out Game:** Found difficult due to complex questions, perceived as geared toward older children.
 - **Mars Rover:** Favorite activity. Group said they enjoyed for its unexpected 3D render and ease of use. Remarked on having some prior coding experience.
 - **Planet Walk:** Enjoyed the AR, but suggested improvement for multiple planets display.
 - **Spacesuit Selfie:** Enjoyed learning about different astronaut suits and specific features like the gold-covered visor. Said there was a lot of new information to learn from this activity.

Interviewer: It looks like you guys did the Breath of Fresh Air activity, Design a Space Orb, and the Pack Your Bags activity. Those all sound familiar, yeah?

Participant: Mm-hmm.

Interviewer: **Awesome. Okay. So you guys answered a couple of questions about them. The first question was about how enjoyable and how interesting was it. And I just want you guys to explain a little bit. So let's start with Breath of Fresh Air. You guys said that that activity was super enjoyable. What did you guys like about it?**

Participant: That was the one with the highlighter marker. So we liked it a lot. We liked how you could like experiment with it. The only issue was the highlighter you guys sent us was extremely dried out. So they didn't get a lot of color on there. We understood the concept, but it didn't work all that well because the highlighter was dried up.

Interviewer: **Okay. I'll keep that in mind. How did you guys – so you said you were able to experiment with it. How did you guys change it up?**

Participant: So we did have more cups, so we used smaller cups, because we needed cups. We put those in like the – but again, it wasn't very colored, because the highlighter was very dried out, so it didn't really visibly change it at all, because there was very little highlighter in there to begin with.

Interviewer: Okay. Sorry about that.

Participant: But we really got a lot of information out of like the follow-up part of it, where it told you what you did and why you did it. The explanation at the end was very helpful.

Interviewer: **All right. So that's Breath of Fresh Air. Okay. Let's move on to the Design a Space Souvenir. You guys also said that one was super enjoyable. What did you guys like about that one?**

Participant: It was cool. That was cool. Yeah. It was really cool, because we got to make our own, so it wasn't like we had to make it like – like a – copy one that was already made. That was cool. That was a cool thing about it.

I'm pretty sure mine was a rocket ship. _____ or planets, like _____ planets. We both did rocket ships. I did a rocket ship with the stars around it.

Interviewer: That looks awesome.

Participant: Mine was a rocket ship blasting all the way to Pluto.

Interviewer: You guys are so creative.

Interviewer: **Pluto. Of course. All right. And then we also had the Pack Your Bags activity, where you guys had the lunch bag, and you had to fill it up. You guys said that one was also very enjoyable. What did we like about that one?**

Participant: That one was like cool because like we didn't know that astronauts got such like such a small thing to put personal belongings in. Yeah, they don't get to bring much with them.

Participant: And then you guys put some personal items in there, and you probably would have liked to bring more, but you couldn't, huh?

Interviewer: **Okay. And then was that all the activities you guys did? I wanted to double check.**

Participant: They did the other four suggested ones, and they have some things to say about those, too.

Participant: Yeah.

Interviewer: Oh, yeah. Sure. So which of the other four _____?

Participant: The In and Out Game, the Spacesuit Selfie, the Mars Rover, and the Planet Walk.

Participant: It seems like there was a mistake in the In and Out game.

Participant: I really liked the Mars Rover, because I haven't been coding in a while. It was really cool, because like I just thought I was going to go on like the 2D image, and then we got a 3D render of the Rover's POV. That was cool. We also did Planet Walk, which that was cool. The only thing I was kind of disappointed about was I couldn't have multiple planets at once. You would summon one planet, and then when you summoned another planet, the other planet would disappear. I think it would be cooler if like you could summon as many planets as you wanted, and then when you clicked reset, they all disappear. Instead of one planet at a time.

Participant: Yeah, so you can like fake the solar system.

Spacesuit Selfie was cool.

Participant: Yeah. I liked the Spacesuit Selfie, because it was really cool to see the other astronauts' suits, because I didn't know that they had like the orange one and the black one. I thought they only had the white one.

Participant: Yeah. Same. I knew they had the orange. I knew – I knew – I knew that there were _____. I didn't know there was a black astronaut suit, though. I feel like that would get very warm, if it was – you were in the sun too long.

Participant: Oh, what was the thing you guys thought was cool about the astronaut spacesuit vizor?

Participant: It has a – we thought it was cool that it has like a covering of gold over it. A very thin layer of gold, so that they can still see, while not getting too warm.

And also, to find out that the sun rises and sets every 90 minutes on the Space Station.

Participant: Yeah. That was cool.

Participant: There's a lot of information in there that we didn't know.

***Interviewer:* We kind of already touched on this, but I'm going to bring it back up. In the survey you guys did, you said one of the things that you learned was learning about how – learning about how much weight of personal items an astronaut can bring with them into space, and that it's surprisingly small. Was there anything else you guys wanted to say about that? Or you guys think you've covered it?**

Participant: Like so like...You can't bring a stuffie, can you?

Participant: No. Unless it was like a small plush.

Participant: I have some small little plushes that I could technically bring.

Participant: Do you have any ideas about that? Do you think that that's a fair amount? Or do you think – what do you think?

Participant: I think that's an unfair amount, because if you were like going to space, and you were packing that little bag, and you wanted to bring like a family photo, or a couple, but they're really heavy, then you can only bring like one or none.

Interviewer: Did you guys have a hard time choosing what to bring?

Participant: No.

Participant: I just went – I just grabbed random stuff.

Participant: I threw my phone in there and a Rubik's cube.

Interviewer: That's a good combo.

***Interviewer:* Okay. Let's see. That one, and then one of the things that you said you wanted to learn about was you wanted to learn more about the elements and elemental science. "I wanted to learn more about more – more planets than just Mars." Did you guys have anything else you wanted to say about that? What other planets would you have liked to learn about?**

Participant: Like any other planet. I want to explore Saturn, because –

Participant: Yeah, learning about Saturn would be cool.

Participant: Yeah, because – yeah, because _____.

Participant: And like what gas is on the layer of Uranus, right? That's the gas planet.

Participant: Maybe some more information about what elements are on the planets would be a nice thing? Their makeup, what they're made of.

Interviewer: Cool. That is – that is good feedback.

Did any of the activities connect to your daily life at all? Like has your family ever talked about space exploration before, or did you find yourself being like, oh, I've done something like this at school, or my mom or dad brought this up?

Participant: Yeah. Yeah. Well, so in our – so in – I'm in third grade, and in our school, there's like modules, and so we're in – I'm in the second module. And the first module was the ocean, and now we're learning about space, so that kind of connects.

Participant: You didn't learn anything about space at school, bud?

Participant: No.

Interviewer: Was there anything specific you guys were talking about in your space module at school?

Participant: So we did like four paragraphs about Galileo.

***Interviewer:* Okay. And then have you guys – have you guys ever talked about space exploration with any of your friends or family before?**

Participant: No, but I have seen like some new vlogs about it on YouTube.

***Interviewer:* There was a couple of different statements, and you got to answer like a before and after. I'm interested in space exploration, I'm knowledgeable about space exploration, I'm excited to learn more about space exploration, and I consider myself a science person. So it looks like the one that changed the most was I'm more excited to learn about space exploration. What made you guys more excited?**

Participant: Personally, it was just like learning about it, I had many unanswered questions. So that made me more excited to learn about it.

Participant: I wanted to learn more about it because I don't – I don't – we're like just – we like just started our space module, and we haven't learned very much. So I want to learn more.

Interviewer: My next question was did you guys use – oh, there you guys go. Did you guys use the space exploration, the DIY app, in any way differently than how we suggested it? So did you try any other of the activities on there? Did you guys explore with friends or anything like that?

Participant: No. But, we almost did all of the activities. I think the only one we haven't done yet is the one with the how water is conserved and reused, right? Because that one seems like it takes a little more time, because you've got to wait for the condensation and stuff. But we will do that one.

And you guys have kind of got an idea about how to do that from plants, with the “terrarium” plants you guys have planted, right?

Interviewer: Did you do them all in one day? Was it a weekend, a week?

Participant: So we did the first three like all in the same day. But then we did the other four in all in the same day. Today. Right before this interview.

Interviewer: My second to last question, in the survey that you guys did – so it was just you two doing the activities? Was it just you guys? Was there anyone else you guys did the activities with? Did you guys have siblings that weren't interested? Anything like that?

Participant: It was just us, but our parents were helping us a little bit with it.

Interviewer: My very last question is just anything else you guys want to tell me about the activities, what you guys did like, didn't like, feedback, how it can be better?

Participant: Well, you guys had a favorite, which was which one?

Participant: The Mars Rover one. It was my favorite, because I was expecting it to just work like literally every other coding game in all of existence, and just be a 2D render, and then we got the Rover's POV.

Interviewer: Did you guys have any difficulty with that? Or did you think it was pretty easy to figure out?

Participant: Yeah. It's pretty easy to figure out.

Participant: It was pretty easy to figure out, but I've been doing coding for a while, so that was like....But it was fun.

Interviewer: Was there any activity you guys didn't really like, or you just maybe wish you didn't do? Anything like that?

Participant: I didn't love the Breath of Fresh Air, because it didn't really work all that much because dried out highlighter. But that's the only one that I was like meh about.

Participant: We did save the materials so we could try it again with like a fresh highlighter, maybe.

Participant: I was meh about In or Out, because I'm only nine, and the questions are really hard.

Interviewer: Okay. I can see that. All right. Anything else? That's all you guys – that's all we got today?

Participant: Yeah. Another thing about the In and Out Game, I feel like a lot of the questions were more directed towards the galaxy _____. Because a lot of the things, it said where in the galaxy, like almost everything it was in the galaxy, but almost none of it was in the solar system.

Participant: It seems to be the same question set from the couple of times that I played it. So maybe that is geared more towards older children than younger children. Because a lot of them were like, this nebula, that nebula, how about this nebula?

Group E: One adult and two children

Summary of Key Ideas

- **Overall Enjoyment:** Participants found the activities mostly enjoyable, though some had mixed feelings.
- **Connections to Real Life:** Participants drew parallels between the coding activity and their own coding experiences, including a home coding course and involvement in FIRST Lego League. They discussed how skills learned in the Mars rover game related to real-life coding and engineering tasks and recalled their visit to the Jet Propulsion Lab and the Mars rover construction process.
- **Learning Outcomes:** They learned about the role of zeolite and its applications, connecting the science activities to broader concepts like pH indicators and climate change.
- **Specific Activities**
 - **Breath of Fresh Air:** Participants enjoyed the visual aspect and the "magic" of the color change using zeolite. Appreciated the provided materials and conducted additional research, learning about what zeolite is and how it's used to trap carbon.
 - **Space Medallion:** Minor issues with the thinness of the index card, preferring stiffer cardboard. One child did not find the drawing aspect engaging, indicating a preference for other types of activities, but there was appreciation for the tangible souvenir aspect.
 - **Pack Your Bags:** Received the lowest ratings but was not deemed terrible. Participants found it straightforward and not very engaging. No significant conversations on prioritizing items, though one participant mentioned wanting to include snacks and the other mentioned constraints by NASA on allowable items for space missions, particularly regarding food.
 - **Mars Rover:** Took a few tries to not crash the rover but found it "cool." Expressed a desire to offer more advanced and different challenges. Despite figuring out the game quickly, one child reported playing it 20 times or more. No significant curiosity sparked about the Mars rover itself.

Interviewer: Overall, when you think about all of the things that you've done with this phone app, how enjoyable were the activities, would you say? Not at all? A little? Mostly? Or very? How much fun did you have with this?

Participant: Mostly.

Participant: A little less fun.

Participant: Oh, yeah, I thought it was – I'd say mostly. It was pretty interesting.

Interviewer: I'm really curious about what you did and didn't like and why – why maybe it was just mostly interesting or a little interesting. So, what about the "Breath of fresh air" activity where you were using the highlighter water and blowing into – mixing it with the zeolite. What was – what did you like about that? What was interesting about that?

Participant: That one was very interesting.

Participant: That zeolite made the color come back. It felt like a magic trick.

Interviewer: Really? Yeah. That was – so, it was the visual stuff, being able to see things change, and it just felt like magic?

Participant: I think it was more of the mystery.

Interviewer: I see. Okay. Was there anything else about that particular activity that made it enjoyable, fun, and interesting?

Participant: Well, I'd say that we didn't know what the zeolite was, so afterwards we kind of Googled zeolite. And it was definitely very good we were sent the materials. Otherwise, if I didn't have the materials I'm not sure I'd really go out and look for zeolite.

I'm not – I know – I think the app said it's some kind of head thing or whatever. [*Inaudible*] for it. And this happens for other science experiments that we've done at home. If I have to buy two pounds of stuff and I only need to use a tablespoon, that just makes me less likely to pursue it.

Interviewer: That's a really good point, that – and that's part of the reason we sent everything is so people could try it out as it was designed. And yeah, we've – we get a lot of really excited feedback about having – playing with the zeolite and seeing all the things that that can do. And so, that's really cool to hear that you did some of your own background reading and research on that. What did you find out?

Participant: Well, we found out that zeolite is a carbon sequesterer. It takes CO₂ out of the air. So, now I'm thinking with enough zeolite we could very much do damage against global warming. Since synthetics are very easy to create, we could pretty easily make – we could pretty easily do carbon recapture. And you make diamonds out of it.

Interviewer: You definitely have a plan. I am excited to hear that. And I'm sure the folks who designed this will be so excited to hear that you're building climate change solutions. That's a definite connection to real life. We'll talk about that in a little bit – more.

Let's move – is there anything else you want to share about that particular activity that was fun, cool, or could have been done better?

Participant: I think if you just – if you disassembled the highlighter into just the ink cartridge that you could pour in, that would be a lot more convenient than just rubbing it on the wall of the plastic cup.

Participant: Yeah, that took a lot longer than we thought it would. Mainly because – initially, when you weren't quite sure what was the purpose of it, and it was pretty clear that if we just ran it down once it wouldn't – it would be very faint. So, we all spent a lot more time rubbing it to get more ink so that our water would be more a neon color.

Interviewer: I think I've seen – because I've seen this done in – on the museum floor, and they'll just take the cartridge out – the ink out of the thing and just put the whole thing in a jug of water and they'll just let it sit in the water.

So, there's – yeah, but there's a whole lot of different ways that we could set this up and different alternative instructions. But that is fantastic feedback.

So, I'm just going to move on to the space souvenir. So, design a space medallion with the aluminum foil. What did you like about that? And what made it interesting or not?

Participant: Wel, the index card was kind of thin. When we were wrapping the index card it didn't feel like it was stiff enough to make round shape.

Interviewer: I see.

Participant: I would have liked to use cardboard circles. I think that would have worked a lot better.

Interviewer: Okay.

Participant: Even a thin piece of cardboard is a bit stiffer than an index card.

Interviewer: Yeah. Okay. The – what you were asked to – so, assuming everything had worked exactly like it was supposed to, what was fun and interesting about that activity?

Participant: It sort of just felt like – it's – I didn't find it that interesting. I mean, I guess I'm not a person who likes drawing the most. I don't do a lot of it.

Interviewer: That's okay. Yeah. Some people, that's not how they want to tap into learning about space, is they want to – they want to Google zeolite; they don't want to draw a picture. But – which is totally valid. So, what I'm hearing is that maybe art isn't your – arts and crafts isn't your entry into space exploration. Any other thoughts or ideas about this particular activity?

Participant: The _____ was pretty interesting.

Interviewer: You thought it was pretty interesting?

Participant: Yeah.

Interviewer: What did you like about it?

Participant: I liked that – just – I liked that you could draw on it and then put it on...

Interviewer: You liked that you could make something that you could have?

Participant: Yeah.

Interviewer: That is pretty cool. I know a lot of – my kiddo definitely likes being able to have an actual souvenir of what they were doing. Did you like any – did you read any of the other sort of information that went alongside with it about why – did it make sense why they were asking you to do this as an activity? Like, what does this have to do with space? Did that make sense to you?

Participant: Yeah.

Participant: I guess you can't really argue it doesn't have a connection to space, since it's literally called a space medallion.

Participant: We designed one for all the different –

Interviewer: Well, and the reason they have an activity like this in here is exactly – there are different ways that people get interested in learning about something. And so, somebody who kind of sees themselves as an artist but maybe not as much as a science person could read about all of the – make their own and then want to know more about other space medallions and then learn – and explore and learn a little bit about other past space missions. So, this is – the intention is that – so that everybody can have something that really excites them. And it's okay if not everything excites you.

So, speaking of not being as exciting or interesting, the "Pack your bags" activity, I think that got your lowest ratings in general. It wasn't terrible, but what would you like to share about that one?

Participant: Well, I know that we could stuff a blanket inside of that.

Interviewer: You could stuff a blanket?

Participant: Yes. That's one.

Interviewer: Oh. Okay. And does the blanket have a lot of special meaning to you?

Participant: Yeah.

Participant: It was like a seven-minute experience, I guess. Just put stuff in the bag. It's just – you put stuff in the bag.

Participant: Well, we thought that – I mean, you wanted to put the blanket in the bag but you didn't think it would fit. And then we spent some time folding it perfectly and it fit right in.

Participant: Folded it and...

Participant: I couldn't find too many things that would actually fit in the bag.

Interviewer: Oh. Did you have some conversations about, then, if you had to make a hard choice? Because if you're going to – if you're traveling on a long space mission – the purpose of that activity – is to help people understand you can only take so much with you on a long mission if you become a space, an astronaut who's going on missions outside of the solar system. Did you have any conversations about how you would decide what was most important to you?

Participant: Not really.

Interviewer: Okay.

Participant: Well, you wanted to put a snack in there.

Interviewer: A snack.

Participant: I think that was [child]. I don't know.

Participant: Somebody wanted to put a snack in there.

Participant: You can't, according to NASA laws.

Interviewer: Yeah, they're pretty strict about how food gets packaged and what goes along. It's got to be nutritious and not make crumbs and get in all the instruments and things like that. So, that –

Participant: I could put my blanket in but it's really hard when the blanket's the size of that Starry Night poster behind you.

Interviewer: Yeah. Yeah.

Participant: Well, it's probably a little bit taller than that Starry Night poster. It's probably a lot bigger.

Interviewer: Well, I appreciate your honest feedback on this particular activity. We're going to scoot down to the Mars rover. So doing the game with the coding. What did you think about that one? What stood out? What was fun about it? What did –

Participant: We crashed the robot first.

Interviewer: You crashed the robot? How did that feel?

Participant: It felt cool.

Interviewer: Did you figure it out at the end? Or how many times did you have to try?

Participant: I figured it out at the end.

Interviewer: You figured it out? Good.

Participant: I didn't do it. But from what I saw it's sort of simple. Maybe you could make a more advanced one. Because I noticed it's just like put the arrows in the direction it needs to go. But if you did – instead of the sign arrows being – going to the side, if you make it rotation, that would be *[inaudible]*.

Interviewer: Ah. So, different challenges or different challenge levels?

Participant: Yeah.

Interviewer: And was it cool for a few times? I hear you did it – did you do it more times after you figured it out or did you just do it one time and then you're like "Cool, I beat the game"?

Participant: I did it, like, 20 times.

Interviewer: Twenty times.

Participant: I have a grand total of zero.

Interviewer: That's fine. Yeah. We're just learning about how people like to use these activities and do people – like you said, if there were different challenge ratings, if there were different things that maybe might make it a little more – a different experience, then we're happy for that. Did you have any conversations about the Mars rover, about any of – did it make you curious to maybe learn more about the Mars rover?

Participant: No.

Interviewer: No? Okay. It was a fun game. What do you know about the Mars rover?

Participant: It's small.

Interviewer: It's small?

Participant: Is it? It's not that small.

Participant: It is that small.

Participant: Really?

Participant: Yeah.

Participant: You probably don't remember when we went to JPL.

Participant: Oh boy.

Participant: What's that?

Participant: The Jet Propulsion Lab where they were building it in the main room. You don't remember.

Interviewer: That is so cool. You actually got to see them making a Mars rover?

Participant: Yeah.

Interviewer: Wow. What was that like?

Participant: Let me see if I can pull up some memories.

Interviewer: Okay.

Participant: Kind of like building a Mars rover. First you get the metal base. You put on the six wheels. You put the body on. You put – then you put other stuff on and

Participant: What? It's simple.

Participant: We saw a lot of stuff there. Remember how they were talking about how it would – how the rover would land without smashing to pieces. You had all those different prototypes with the balloons and the parachutes and the –

Participant: Yeah, science.

Participant: Maybe you were too little.

Participant: I just remember a lot of white people running around in a white room with this giant white rover in the middle.

Interviewer: Yeah. That's super exciting, though. So, I know when we talked a bit about the zeolite and the "Breath of fresh air" and sort of the connection – there's some connection to real life that you brought up, and we talked a little bit about packing your bags and personal items and what's important to you for human space exploration. Did you see any sort of connections to your real – your life or just human connections with the Mars rover game?

Participant: So, it's the closest – in my opinion the closest would be Mars rover, the coding. That's – packing your bags and traveling maybe. Usually you have a lot more space.

Participant: Yeah. If you're going on a – one long trip to three different places.

Interviewer: Say a little more about the coding connection with the Mars rover. I'm curious where your brain's going there.

Participant: What?

Interviewer: Can you say a little bit more – you mentioned coding as being a connection to – a relevant connection, something that comes up in everyday life. Can you say a little bit more about that? Where's your brain going with that idea?

Participant: It's sort of like "Move up. Move right." That's steps, which is technically code. And my mom – I think my mom started running a little coding club. Not really a club, actually. It's more like –

Participant: It was like a course.

Interviewer: Okay.

Participant: Scratch coding. Making games and stuff from scratch. I know that these guys are also in FIRST Lego League in school, so...

Participant: Yeah, it connects that way.

Interviewer: That definitely makes sense. That would be a connection to your own life even though you're not up on Mars. Yeah, the same sorts of skills. I –

Participant: In fact, we're actually in the FLL room.

Interviewer: Oh, wow. Yeah, I was wondering what those icons were behind you. So...

Participant: Yeah, those are those – yeah, the six axioms, the core values. And then, over here there's the wall of maps.

Interviewer: That is amazing. So, feel free to chime in on if you have any other thoughts or ideas about the specific activities. I want to move on to the question where we asked about what you learned from these activities. And there's no right or wrong answers. And sometimes the learning can be really big ideas. Sometimes it can be really small things. And what was in the survey is that you learned about how astronauts get to bring along personal items. But it's a very tiny bag and so they have a very limited space to – and they have to make decisions. And you also learned about zeolite. Is there –

can you tell – is there anything else that you want to share about what you learned or how the activities helped you figure that out or prompted further exploration?

Participant: I don't think so.

Interviewer: You don't think so? Are there –

Participant: Nothing jumps – I don't have anything off the top of my head.

Interviewer: Okay. And I know we've talked about it in other areas too. I just want to make sure everybody has an opportunity to dig in. Can I ask, did you learn or figure anything else out about just science or engineering in general?

Participant: Magic trick.

Interviewer: Magic trick? I think that's actually chemistry, what's going on there, the way the –

Participant: That was great.

Interviewer: Yeah, with the zeolite, the – what's actually happening is that it's – the highlighter is a pH indicator and pH is a concept in chemistry. So, it's sensing acidity or –

Participant: Ah, yes, the purple cabbage test.

Interviewer: Yes, it's similar to the purple cabbage. And so, another – and I'm – because y'all seem like you're super interested in this kind of stuff, another connection that is actually not really space-related is acid rain and ocean acidification. And you mentioned about climate change and carbon sequestration, and that's actually why zeolite is often sold in pet stores, is to help balance and filter pH in fish tanks and things like that and do oxygen – help to oxygenate the water. So, we're all connected in all sorts of different ways.

I'm going to scan through a couple of my other questions. So, it definitely sounds like you had some wonderings about what is zeolite and what does it do?

Was there anything else that you were wondering about, either the first time you were using activities or since you've used them?

Participant: No.

Interviewer: Okay. So, I'm going to skip us down to – there were some before-and-after rating questions and it looks like that using the app didn't really change things much. I'm getting the sense, though, that you were already very interested in a lot of these topics, so we aren't going to see as much change afterwards.

But could you tell me, is there any other reasons why you sort of – your interest in space kind of stayed the same, your knowledge about and your excitement stayed the same? Or was it basically you were just really interested and excited and knowledgeable to begin with?

Participant: I think you could say the second. Yeah.

Interviewer: Okay. Would you say that you consider yourselves science people?

Participant: Yeah. I'm more mathematics.

Interviewer: That counts. Math is science.

Participant: Yes, if you look at STEM. Or STEAM.

Participant: STEAM?

Interviewer: Well, here's a question –

Participant: It's science, technology, engineering, art, mathematics. And it's known as just STEAM without art.

Interviewer: Well, here's a question for you all. What is science, then? If it's part of STEM, what is science?

Participant: That's a challenge.

Interviewer: Science is a challenge?

Participant: No. A challenge to define.

Interviewer: Ah. Well, I'm kind of taking us off course. I was just curious when you said "I'm a math person but I'm not a science person," or you don't necessarily see yourself as a science person. So, we're also very interested in learning about how groups use the app. Did you do anything differently than what the app said or make changes to sort of make it more usable? What did

you do – how did you change the instructions or experiment and play with the activities?

Participant: Well, first of all, we used the highlighter a lot more. That's the first major change, I guess.

Interviewer: Okay. Did you try any of the activities multiple times, other than the Mars rover? We already talked about that. But did you –?

Participant: No.

Interviewer: You just did it once? Okay.

Participant: "In and out."

Participant: Oh, yeah. That one.

Interviewer: Did you figure out – did you get – do you know if you got to see all of the questions? Because I haven't tried it enough times to know how many questions there are to answer.

Participant: There are, like, 10 questions.

Interviewer: There's just 10? Okay.

Participant: Well, it could be randomized.

Interviewer: Well, there is that too. Was there any –?

Participant: Standardized test taking. They have a pool of 100 questions and each time you see 10. So, you're almost always guaranteed to get a random one.

Participant: I don't know if there's – I did notice there were lots of questions.

***Interviewer:* Do you feel like – were there any of the things on the app that you would want to do multiple times? Or was it more of –**

Participant: I liked the Mars rover.

Interviewer: Pardon? The Mars rover? You – that one you want to keep playing and doing multiple times.

Participant: I think the things we did multiple times are things we're going to want to do multiple times. So...

Interviewer: Can you tell me what they are?

Participant: Mars rover. And "In and out." We've done – he's done them multiple times. I think we'd do them multiple times.

Interviewer: But none of the sort of interactive activities where you're building something or making or creating something or demonstrating a phenomenon? Sort of one time was good?

Participant: Well, once you know the magic trick...

Interviewer: Are there other people in your house that you would want to show that to?

Participant: I've shown them to – I've shown it to three-fourths of the house already.

Interviewer: Oh, okay. What about other people, like at your school or other family members?

Participant: We don't go to school. We don't have school. Well, we don't get outside this building. We just stay home to go to school.

Interviewer: That's cool. That makes sense.

Appendix B: Code Definitions

What are 1 or 2 things that you or your group learned about?		
Code	Definition	Example
Surviving	Ideas and concepts about basic humans need to survive in space or on long missions	“How to protect humans from the harsh conditions on the moon Choices will need to be made about what is most important”
Thriving	Ideas/concepts that go beyond basic survival. during human space exploration.	“This activity gave my child a chance to learn about all of the things necessary for humans to inhabit a base on the moon, including growing food and making a plan for exercise.”
Scale, time, distance	Understanding and context based on human perspectives (ie., it would take so long to get somewhere, it’s so far away, the planet is so large)	“Distance to Mars and the moon.”
Space and planets	Names, information, and details about space and celestial bodies. Includes information about radiation in space	“...how mischievous radiation is in space and how we are protected on earth”
Chemical reactions/ chemistry	How zeolite works, CO2	“How to create the correct gas/chemical mix to create breathable air in space.”
Technology	Space suits, filtration, code, food storage and food creation	“I didn't know Mars Rovers had to use a code from Earth to move around and I learned that as little as 3 pounds of weight can affect a rocket's takeoff and fuel usage.”
Human space exploration & missions	Specific missions, names of shuttles, ISS and questions about future space exploration and living on different planets, general ideas/concepts related to human space missions and exploration	“New lunar mission; learned what would be useful to bring”

What about this activity made you want to learn more?		
Code	Definition	Example
Content	Information presented in the activity/app. What people were learning about or seeing. For example, I learned about planets, space, distance, how astronauts survive, space suits, etc...	“I would like to know more about what astronauts need to master to be considered for space travel/flight.”
Format	The way the activity or app was designed or the way you were expected to interact. For example, it was hands on, we got to do experiments, the Augmented Reality	“How to make art with aluminum foil and cardboard?”
Facilitation	Understanding and context based on human perspectives	“Having facilitators engage with kids and ask pointed questions piques their curiosity”

What are 1 or 2 things about human space exploration or NASA missions that you are curious about after doing this activity?		
Code	Definition	Example
Activity specific	Comments and questions about specific activities. Includes process questions/wonderings and desire to learn more about aspects from the activity	“Growing plants in space. It was interesting to think about. I like the hands on learning and coming back to check on it over time. Exploring other galaxies was fun too. The in or out game made me learn a bit and want to know more.”
Past & present human space exploration and missions	What has happened in the past or is being planned/happening right now. Includes specific missions, names of shuttles, ISS and general ideas/concepts related to human space missions and exploration	“I'd like to see real medallion's from real astronaut's.”
Future human space exploration & missions	The near and long term future possibilities of human space missions and exploration. Includes human habitation on Mars or the moon; the need or likelihood for interstellar travel, and logistics involved in planning or executing future missions	“I would like to learn more about unmanned space exploration.”

How did the activity make you feel like a NASA astronaut or scientist?		
Code	Definition	Example
Engaging	Activity felt close to the 'real thing' and held participants attention	“The coding for the Mars Rover and the space suit fitting were things actual astronauts have to do, so I felt like an astronaut.”
Knowledge Acquisition	Learned about new concepts and encouraged further learning	“The code a rover activity made the kids excited about controlling something on Mars and looked up pics of Mars to see if it would look like on the app.”

Other Codes Applied		
Code	Definition	Example
None/Nothing	Indicated the question didn't apply or said 'no'	“IDK”
Not Specified	Respondent gave a vague answer	“Everything!!”
Other	On topic response that did not fit into an existing category	“He is still using the design from the medal several weeks later.”

What in your daily life connects to something you learned or did in this activity?		
Code	Definition	Example
Hobbies & interests	Relating aspects of the app or activities to their own lives, hobbies, interests, or personal connections, such as pets, artwork, favorite foods, or favorite activities.	“Mars Rover game reminds me of coding and wanting to learn to drive. I like to garden and I like to plant things for the space garden. Ice orb reminds me I like to play with water.”
Prior knowledge	Drawing connections to prior knowledge, classroom learning, and previous exposure to topics related to human space exploration	“I learned on the tv stars can hurt your eyes so I used the gold to protect”
Home & Everyday Life	Making connections to their own daily lives at home.	“I thought about air quality in my house”
Sustainability & Resource management	Making connections between the need to conserve or manage resources during human space exploration missions and the need to conserve and manage resources on Earth	“How we could reuse water.”
Human Needs	Ways that the activity or app connected to universal human needs --surviving and thriving in a general sense. Includes meeting essential human needs for survival like oxygen, water, and food as well as maintaining health and wellbeing.	“Oh, a lot of things! The activity makes you think about all the things we need to do in a day and how these would adapt to a lunar environment.”
Comfort & Entertainment	Identifying elements related to leisure, entertainment, and personal preferences, such as TV, video games, music, and favorite foods. <ul style="list-style-type: none"> ○ References to video games, TV shows, music, playing outside, and other forms of entertainment suggest that individuals value activities that provide enjoyment and leisure." 	“The issue of being bored on Earth is difficult enough. Being bored in Space would be much worse”
Problem-solving (Critical thinking)	Referenced ways they applied this 21st century skill -- Apply logical thinking and reasoning to analyze problems and choose the best solutions considering the weaknesses and strengths of each alternative solution.	“Using the items you have to make the best out of situations”

Appendix C: Statistical Tests

Wilcoxon signed rank test was used to determine if changes in agreement ratings for the following statements before and after using activities were significant. P values of less than 0.05 indicate that the differences between the two samples are very likely (95% confidence rating or higher) meaningful differences and not the result of chance.

Museum-Based Activities

	p value
I am interested in Space exploration	0.000
I am knowledgeable about space exploration	0.005
I am excited to learn more about space exploration	0.003
I consider myself a 'science' person	0.078

DIY App

	p value
I am interested in Space exploration	0.000
I am knowledgeable about space exploration	0.033
I am excited to learn more about space exploration	0.036
I consider myself a 'science' person	0.480

Appendix D: Open Responses

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

Museum Based Activities

- 1. We are sending people to the moon 2. We can build structures on the moon
- 1. You need to have gear, but not special or fancy...basics. 2.you can bring pets in space.
- 1) Don't go to Mars because you could die (radiation) and it takes a year. 2) astronauts get medals
- 1) oxygen 2) mars is really far from earth
- About moon
- Air in space exploration
- Astronauts get to design a space medallion
- Breathing in space Use of plants in future
- Carbon dioxide in ISS
- Carbon dioxide scrubbing rebreather system for space
- Chemicals & earth
- Cleaning air in space and how mischievous radiation is in space and how we are protected on earth
- Co2 and the reverse cycle
- Communication is always key.
- Distance mars is from earth Radiation is on mars Coins that are made for each trip by astronauts How to purifying the hylighter water
- Distance to Mars and the moon. Importance of supply management in space
- Food sources on the moon base
- Getting clean air and that astronauts design their own medallions
- How astronauts reuse the air that they have in space.
- How humans are able to get oxygen out of the atmosphere in space
- How to breathe air in space
- How to create the correct gas/chemical mix to create breathable air in space.
- How to make a roof. Need for hygiene.
- How to protect humans from the harsh conditions on the moon Choices will need to be made about what is most important
- How to remove co2 in space!
- How we can breath the same air over and over again in space.
- I never knew about the coin in space.
- Importance of human space
- Insulation materials
- Learned about keeping heat in.

- Learning to prioritize items and learning to design the structure to best utilize the inside and outside space
- Lots of types of radiation, black holes are stars
- Making air breathable
- Mars. Oxygen and Carbon dioxide and how it applies to space travel.
- Multiple ways we can clean air for breathing in space.
- Need a lot of different materials to survive in space. You have to adapt.
- New lunar mission; learned what would be useful to bring
- Oxygen in space Thinking about logistics of going to space
- Oxygen recycling Danger of radiation
- Picking what were the priorities to survive and working together and coming up with ideas
- Planet size, radiation
- Planets move, space recycling
- Radiation and chemical reactions or changes that can help or damage things depending upon the reaction.
- Radiation on the way to Mars and on Mars will be a problem. Astronauts have a way to get the carbon dioxide out of the air. They use this on the space station.
- Radiation, medallions, size of planets
- Resources needed in space and the decisions that need to be made about what to bring and leave behind
- Star clusters
- Supplies needed to survive in space
- Survival in space. Kids asked how will you go to the bathroom.
- Survival item vs comfort items
- That astronauts get medallions after they come back?
- That minerals are used to clean oxygen
- That you might need prepared meals in space.
- The distance between Earth and Mars
- The essentials for survival
- The moon :)
- The possibility to build a base on the moon. The astronauts need to be protected from the sun.
- The solar reflecting roof
- The sun is harmful to humans on the moon. They need extra protection.
- There were a couple of things missing. Restroom, ceiling. Maybe more instructions on the fact that you can use all the blue ones. There were instructions about using only 4 green blocks so that was good. Wasn't sure about the blue ones.
- They need to take water to the moon Jupiter has a lot of moons
- Things a moonbase might need.

- This activity gave my child a chance to learn about all of the things necessary for humans to inhabit a base on the moon, including growing food and making a plan for exercise.
- Tough to grow plant in space
- Use of limited resources Value of space
- We learned about space medals
- What is needed in space
- You can get sunburned on mars.
- You have limited stuff to bring
- You to recycle..... a bunch
- Zeolite bonds to co2

DIY App

- 1) how to control a rover 2) learned about hot and cold planets
- Astronauts bring along personal items in space but the bag is very tiny. We also learned about zeolites.
- Astronauts can't bring much to space! You breathe out co2.
- Astronauts only have a teeny tiny pack for personal items in space.
- Different objects in our galaxy vs. solar system Variety of space suits
- Growing plants in zero gravity was much different than on Earth. The distance between certain planets are really different from the distance between others.
- "How astronauts itch their noses and space suit features
- That poo is left behind on the moon"
- How difficult it can be.
- How much weight of personal items an astronaut can bring with them to space. It was surprisingly small. I learned that zeolite helps take the co2 out of the air in a space craft.
- How oxygen is made and excess CO2 is dealt with in space.
- I didn't know Mars Rovers had to use a code from Earth to move around and I learned that as little as 3 pounds of weight can affect a rocket's takeoff and fuel usage.
- I learned about dwarf planets other than pluto
- i learned about how salt helps ice melt and about astronauts's spacesuits
- I learned about programming the Mars rover, and I also learned how big the Milky Way really is, from the in or out game.
- I learned about scientists finding water in other places in our solar system. I learned that water is attracted to itself! Veggie sounds so cool.
- I learned about the different space suits that people wear. I also learned about what happens to the air you breathe out on the spacecraft.
- I learned about the order of planets and space gardens.
- I learned how the air is scrubbed of co2 in the space vehicles.
- I learned that when you are in space you need to find different ways to make oxygen because there are no plants in space.

- It takes time to get instructions to Mars Rover. What you breathe in is oxygen and you breathe out is CO₂ (carbon dioxide)
- Just blowing in water can cause a chemical reaction.
- Just HOW big the sun is in scale to other planets and the asteroid belt and Kuiper belt were 2 things I didn't know were in the solar system. Also learned that there are possibly oceans beneath moons and not just earth.
- Learned about how carbon dioxide is removed to keep air safe to breathe in the space station. Learned why it is difficult to take personal things into space as every bit of weight counts, and how valuable the things brought back from space travel are.
- Pictures of the planets were really neat. What things were made of and where they were located.
- Planets are really far apart! There's different kinds of space suits. I thought there was only one.
- That astronauts use medallions to remember their space flight. That astronauts bring bags into space full of personal items.
- That dwarf planets existed. also I learned that Mars Rovers had a bunch of code sent to them at the same time.
- The distance from the earth to the planets. How food is grown in space
- The size comparison of the planets is fascinating. The definitions of space objects were helpful.
- There are many moons bigger than our moon and about where the planets are in our solar system
- The mystery of what's deep inside planets and how scientists are thinking beyond the surface. The vast distance between the rock planets and further planets, as well as beyond the solar system.
- Too many to name!!
- We learned about building a habitat on an alien planet and some of the challenges with that. Also about communication challenges when you are far away from earth.
- We learned about stuff inside and outside the galaxy. We also really enjoyed the experiment with the highlighter and learning about carbon dioxide.
- Well mom learned that Pluto is no longer a planet! And daughter learned about how big and small the planets are in comparison to the sun. We learned about how water is conserved in space with filtration.
- What different planets look like. Relative distances of planets from the sun.
- What the planet looks like what a space suit is like

What about this activity made you want to learn more?

Museum Based Activities

- All of them
- All the different materials and how to use them
- Astronauts
- At some point, humans may need to live on the moon
- Black holes
- Breath of fresh air and danger zone.
- Bringing thoughts to our mind. Moments I wonder moments
- Buildings on the space base
- Costume of astronaut
- Current moon base plans by NASA
- Definitely curious now that I was placed in that position.
- Having facilitators engage with kids and ask pointed questions piques their curiosity
- How does the chemistry work
- How humans would survive in space
- How the people asked me questions
- How to get the supplies needed to the moon
- How to make art with aluminum foil and cardboard?
- Hydrogen and carbon and the effect on light
- I already knew about this in the news and about how they are going to do it.
- I don't know
- Interested in a career in moon exploration
- It is fascinating science! I like science and the Mars mission brings up new problems to solve. It is a long way away. So solutions will be new. There is a lot to learn.
- It was fun and engaging
- just Refreshed my curiosity
- Knowing what a need to get for space
- Learn more about the base camp and survival on the moon.
- Learning about the effects of radiation on growing food.
- Legos were fun
- Love learning how small we are, and how big everything else can be
- Made me more curious about what they are doing nowadays.
- Made me think about exploring space.
- Moon structures and building is interesting
- NA
- Next steps for moon travel
- Not much
- Opened my eyes to things I didn't know
- Other people's answers
- Overall interest
- Radiation

- Relationship to actual events
- Science
- Science experiments are fun,!
- Seeing the beads clean the liquid.
- Seems fun,
- Talking about electricity and wanting to learn more about what it is like to live on the moon.
- The ability to grow food in space to help w carbon dioxide
- The Breath of Fresh Air experiment learning about how they breathe in space
- The experiments
- The hands on quality
- The idea of problem solving how to get plants in space to help with oxygen
- The importance of the "thrive" items
- The reaction of the chemicals
- The science of living long term in space
- The space I like space
- The technology that that would use in space.
- The use of chemicals to make air
- There are fewer resources so you have to be creative with resources
- Thinking about building
- Thinking about process of building on the moon.
- Thinking about the complexity of the task of visiting Mars or building a base on the moon
- Thinking about what will be required to establish a base on the moon
- We've been talking about space tris with the instructor
- What they'd actually build

DIY App Activities

- All of them; it was fun!
- Being able to do an experiment, not just learn about it, like in the Mars rover game and the highlighter ink in water experiment.
- Cabin dioxide removal experience and space medallion.
- Designing the space medal was cool, and I also liked the experiment with the yellow highlighter and the zeolite.
- Having activities as a way to connect with education in a simple and fun way made it more accessible to people like us who couldn't or wouldn't understand a lot without this app.
- How it made me think that there was more to learn about than just the earth.
- I liked how the astronauts have to plant food. I liked the mars rover game on the app.
- I liked the experiment where I cut the bottom of the cup off because it sparked interest in me to learn more about the planets and rings.
- I liked the highlighter one with the carbon dioxide.

- I think it opened up more curiosity for me, and gave me more foundational understanding. I feel more open and interested when reading the news and see space topics come up. I want to continue learning and understanding more.
- I would like to know more about what astronauts need to master to be considered for space travel/flight.
- ice orbs and plant ones
- Ice orbs! I want to learn more about those. I also liked growing the seeds. (from my 9 year old)
- Imagining ourselves going to space. The activities were interesting.
- Mars rover control Breath of Fresh Air In or out game
- My child loves space so it makes him want to learn everything he can
- Response from 10yr old- some of it was interesting, so maybe I'd want to do more things or watch videos about space
- See how they live and want to know other ways of how they live
- Seeing the ice orb made me want to learn more about planets
- "space suit construction
- relative distances of the planets"
- The amount of time it takes to receive a signal back (mars rover) makes you anxious but also mindful that you need to plan.
- The breathing exercise
- The craftiness and hands on exploration
- The different galaxies and black holes were really interesting and I want to learn more
- The experiments themselves, hands on learning and easy ways to understand what was being taught. The activities made me realize how much I can still learn about space.
- The hand on experiment, but the absorbent didn't work. But very cool.
- The hands on activities were fun, especially making the medal.
- The ice orb activity was especially fun, but even that didn't pique my son's interest in learning more.
- The interactive nature lead to many good questions.
- The kids wanted to learn more about the actual distance the planets are from the sun.
- The Mars Rover activity sparked lots of conversations about how we explore Mars.
- The planets looked cool and there was a bit about a space garden.
- The rover and steering made us want to learn more about how communication works between the systems.
- The Space Garden was neat and cool to see happen. I liked learning how the gardens can be grown in different environments of gravity. The plant walk was fun to do with my brothers. We would stand around the planets and then compare them in size.
- There were many questions my children had about space that I couldn't answer, thus resulting in me wanting to learn more so I can teach them more.
- They're really fun and immersive- not just clicking buttons on the app
- Trying on different space suits

- We are forced to learn at school. I would not use the app on my own. I would use it at school though.
- We are more curious about what personal items people have brought.
- We've already done some astronaut research after a recent space unit study, and these activities made us interested to learn more about astronauts and their specific experiences in and contributions to space exploration.
- When we put in zeolite to the carbonic acid water it made it brighter which means it took the carbon element out of the water.

What are 1 or 2 things about human space exploration or NASA missions that you are curious about after doing this activity?

Museum Based Activities

- 1) how many astronauts go into space a year
- All space is a hyperfixation for the child
- All the hazards
- Are people gonna live on the moon How can I better see stars and planets
- Basically increases overall interest in the topic of space in general after visiting here
- Can humans survive on the moon?
- Creating new ways for human survival in space and further research and exploring.
- everything
- Everything, James web photos and information
- Food growth in space
- Food in space
- Going to the moon.
- Habitat suitability, ways of making air breathable and creating heat
- How are they going to do it?
- How astronauts decide priorities while having limited resources
- How can people live on other planets
- How do they get oxygen
- How do we eat and deal with waste in space. It is far, and you need to pack everything to you need.
- How long humans can be in space
- How long is Space trip to the moon How the astronauts eat
- How many plants are on the space station now
- How many trips they are taking there.
- How much supply is needed per person per day
- How supplies would get to space. How people would navigate on the moon
- How the moon mission will go
- How to make hard choices... and what are our goals.
- How we are going to build and settle on the moon

- How we evolved from Earth to space
- How will houses look
- How you would build the technology.
- How you would survive
- I'd like to see real medallion's from real astronaut's.
- Learning about what the missions will be about.
- Maintaining health in different gravity How to use and gather native materials
- More recent moon visits
- Not sure
- Planning for human habitats.
- Space tourism and how quickly that will grow
- Space travel and gravity
- Supplies they bring
- The applications for the future on earth
- The objective in general
- Unsure
- Watch More documentaries
- Water recycling & waste management
- What will the future in space be? How much can we accomplish in one lifetime?
- What happens when you cry in space
- What is currently being done to actually build a habitat in space
- What is in the craters.? -is there life on the moon.? -are there different elements on the moon.?
- What is put on the spaceship to ensure oxygen for astronauts
- What it would it be like to actually live on the moon.
- What life would be like on a space station
- What structures will be used on the moon
- What the moon base will be used for
- What's going on currently.
- Will humans have to go to the moon?
- Women's participation and perspective in space exploration.
- Zeolite?

DIY App Activities

- 1. How long does it really take to get to the moon or other planets? 2. Can you really terraform Mars enough to live there?
- Are we ever going to try to land on a planet besides Mars? Where all of our satellites, probes (like voyager) and rovers are. It would be really cool to have a map of the solar system with all of them placed on it. Maybe you could click on a spacecraft or planet to learn more about it.

- Can't believe we have been to some of these places. How do we know what they are made of?
- Europa clipper mission this year And more about Hubble space telescope
- Everything!!
- Exploring outside our galaxy. More about the ice orbs
- Future space missions
- Growing plants in space. It was interesting to think about. I like the hands on learning and coming back to check on it over time. Exploring other galaxies was fun too. The in or out game made me learn a bit and want to know more.
- How astronauts get by with such little personal belongings.
- How big are the sleeping areas of astronauts? Are any other waste products besides astronauts urine can be or is recycled while still in space.
- How did they get the international space station into space?
- How do scientists control the Mars Rovers? What does it involve to take an animal to space?
- How do you get enough for a trip?
- How far away in miles are the planets from earth? More about what it would be like to live in space
- How people on earth are able to communicate with the rover and/or people on the space station
- How scientists get through ice on other planets; how big plants grow in space.
- How they prepare.
- I want to know more about the Mars rovers. I want to know more about growing food in space and food experiments in space.
- I want to learn about specific space missions. I don't know about any. (From my 9 year old)
- I want to learn about the first mission to the moon.
- I wasn't really any more curious.
- I wondered why they stopped going to the moon.
- I'm wondering what a typical day is like and how simple things (like eating!) take place. I really enjoyed learning how they grow food in space.
- ice orbs, plants and space food
- It's easy to forget about all the things we need when we travel. That is amplified when we talk about space travel. We got curious about all the stuff you'd want and need to survive. We were very curious about how to bring the creature comforts.
- Life on other planets, moon landings and orbiting, the ISS
- My kids say : they want to know more of what it is like for the astronauts. Eating, bathroom. They want to know real facts about what it's really like in space.
- None - see #5
- Not sure, my son did it pretty independently.
- Psychological impact of being disconnected with asynchronous communication. I'm also curious about the low gravity growing of plants

- Some things I am curious about is how planets look like and their atmospheres.
- We'd like to learn more about the specifics of shuttles and know more about the percentage of missions that include humans going to space.
- What are exactly dwarf planets and I also wonder how big is a rocket ship?
- What astronauts bring in their personal kits. What other space medallions look like and who decides what goes in them
- What does it take to coordinate designing, building and programming the deep space probes?
- What dwarf planets look like and are they hot or cold?
- What has been tried to go closer to the planets by the sun
- What other personal items did people bring? Could they bring their favorite snacks? How did they program the Mars Rover?
- What the ultimate goals are, are we looking for undiscovered areas? Is it even possible to go to other planets? Such as mars.
- What was the first star that died. How many moons are in the solar system.
- When will humans be able to go to Mars and asteroid belt.

While doing the activities, was there anything you were wondering about or places you wanted more information?

Museum Based Activities

- 1. What is zeolite, really? Is it used in fish aquariums? 2. What is it in the marker that reacts to carbon dioxide? How does the zeolite turn it back / absorb the carbon dioxide?
- Basically about overall space in general. I've always been interested in learning more about it, and now that my children are also interested it gives me the best reason to read and learn more about it!
- Building of the rockets and telescopes and how humans know certain things about what it is from.
- Dwarf planets
- He is still using the design from the medal several weeks later.
- How big to draw the dots on the solar system activity for scale would have been helpful.
- how does the balloon not pop on the ice orb
- I want to learn more about elements and elemental science. I want to learn more about other planets besides mars.
- I wanted to keep learning about everything .
- I was curious about Mars.
- I wasn't wondering anything when I was doing the activities.
- I would like to learn more about unmanned space exploration.
- I would love if there was more information about the mars rovers, maybe with the drive a rover game. On a similar note, maybe all of the games (in or out, drive a rover, spacesuit selfie) could be under a Games category instead of mixed with the activities.

- I'm curious about how many more dwarf planets there are.
- If you have to send an individual code each time something gets in front of the Mars Rover, how long does that take? Or do you send large sets of code over a longer period of time?
- In or out game- there were not very many places outside the galaxy.
- In the in or out game i was curious on places and things and then want to look them up to know more and where it was compared to us.
- Maybe the moon
- More information on the history of discovery of dwarf planets
- My daughter said she wanted to know about Saturns rings and what they were made of. And we also were interested in other asteroid belts in the solar system.
- no it was all quite good a lot of information
- Not really, I wouldn't even know where to start with questions to asked The activities did a great job at opening up ideas and questions I didn't even know I had.
- Pictures of actual space medallions; info on Mars Rovers; more information about spacesuits and pics of them
- Pluto
- Solar system vs. galaxy became repetitive and somewhat obvious, an additionally opportunity for information would be nice After the rover game, it just ended, and didn't give feedback re: why and what next
- The moon and mars
- We couldn't get the selfie one to work
- We liked the info in the activities. We loved driving the rover. The planet walk was a little challenging at first. We had to try it a few times.
- We used Wikipedia to learn more about the zeolites.
- Yes, about astronauts life in space and more systems, like air purification, that make living in space possible.

How did the activities remind you of your daily life?

Museum Based Activities

- Achieving shelter and basic needs
- Air quality.
- Balance between quality of life and survival
- Breathing (2)
- Breathing air
- Building with legos (2)
- Cat litter and zeolite
- Choosing resources
- Clean air is important on earth too
- Cleaning the air

- Climate change. Can we use what we know to reduce the levels of carbon dioxide in Earth's atmosphere?
- Co2 is bad for you
- Daily necessities
- Design and art
- Environmental concerns and conceptual crossover
- Essentials for building a successful home life
- Gardening and planting plants to create oxygen and help taken in carbon dioxide.
- Good luck charm
- Growing micro greens inside
- Having plants.
- Heat
- How much oxygen we breath and how much radiation we have
- How much radiation am I exposed to
- How we could reuse water.
- Humans will need the same things we use on earth except oxygen
- I don't know
- I learned on the tv stars can hurt your eyes so I used the gold to protect
- I live with a space-obsessed child and hear about it daily
- I thought about air quality in my house
- IDK
- LEGO building
- Legos (2)
- Look at sky different
- Maintaining our indoor plants to help with air quality in the house
- Making the most out of the resources available
- NA
- Need for food and hygiene
- Not that I can think of right now
- Oh, a lot of things! The activity makes you think about all the things we need to do in a day and how these would adapt to a lunar environment.
- Oxygen
- Oxygen and life
- Pets and refrigerators
- Prioritizing wants and needs
- Reading!
- Running and using reflects cloth after races to recover
- Science class
- Sharing things we love and bring with.
- Star mapping
- Talking about space

- That to be grateful for what u have because some ppl don't
- The issue of being bored on Earth is difficult enough. Being bored in Space would be much worse
- Unsure
- Using the items you have to make the best out of situations
- Wants vs needs
- Watching the stars
- Water and oxygen is key
- We do a lot of legos and they like space
- We need entertainment like they plan space travel to include it

DIY App Activities

- Because it was interesting to see how they incorporate basic things that can connect our world to space and daily life
- Breath of fresh air reminded me that I need to breathe in order to survive
- Breathing oxygen and talking about what happens to the CO₂ we exhale. Comparing packing for space to packing for spring break.
- Coding a rover was similar to other coding projects I do; we garden a lot at home and playing with ice is something I like to do
- Definitely the space garden - we have a garden and like to grow our own food and the kids love gardening. It built on prior knowledge we had and helped us imagine the challenges of gardening without gravity's help!
- Drawing and experimenting
- How very different doing daily things on Earth is compared to doing similar things in a space vehicle.
- I carry my blanket everywhere and I was happy to find out I could fit it into the bag.
- i help mom with plants in summer I color a lot
- It connected my interest in space and the solar system
- It made me aware of an area of life and the universe I don't think about enough and how insignificant I feel in comparison to what's out there. And we like the breath of fresh air and understand co₂
- It made me think about the air I breathe and how much stuff I use every day.
- It was interesting to compare and contrast space realities to our daily life.
- It's there everyday are we focusing on it, seeing it and learning and thinking about it?
- Mars Rover game reminds me of coding and wanting to learn to drive. I like to garden and I like to plant things for the space garden. Ice orb reminds me I like to play with water.
- Mars rover, you have to code yourself and code others some times. Pack your bags, when you go on trips and school Ice balloons, it's cold and snowy where we live
- Most of them didn't but they were still cool to experience
- Planet walk gives the distances in something I can contextualize. The mars rover planning really reminds me of asynchronous work and communication

- Planting a garden. Coding computer games
- Reminds us of all the everyday activities but to be in space
- Simple activities combined with the challenges of space
- Some of them were like video games or things we do at home (garden)
- Space science doesn't remind me of my daily life.
- The breathing and how we need Oxygen.
- The gardening
- The pack your bags reminded me of traveling on an airplane. And it helped me think of what is important to me.
- They connected to my daily life by the Mars Rover being similar to driving an RC car.
- They didn't that much but some stuff I kind of learn in school.
- They didn't- aside from the packing one, which reminded me of packing for a trip
- They reminded us of our daily life by using tools we have at home to learn about or create something!
- We are so small according to space and yet so big according to animals and such on this planet
- We decided to do some of the activities That weren't sent to us as well, my daughter enjoyed the ice orb one the most. We were reminded at how amazing and smart humans can be to have made Such tremendous discoveries! And how grateful we are for their explorations
- We do a lot of gardening in our back yard, so "Space garden" compared well.
- We like to grow plants and do experiments, so that was connected to daily life.
- We need plants and water in our life and it was cool to think of it on other places in space. I like coding so that was something i use. The distance and sizes of places is something i have done before.
- We pack bags to go on vacation and we have limits on how much we can bring. Our mom lets us each bring a small bag of things that are not clothes.
- We wear clothes (which connected to the astronaut suit) we pack items when we travel (which connected to the pack your bags activity), and we had to walk our property for the space walk
- Well, I draw and a few of the things brought me back to my daily life so there
- When I'm in Science class I could apply some of the information I learned.

How did the activity make you feel like a NASA astronaut or scientist?

DIY App Activities

- Because it felt like I was moving the rover
- Because you can code a mars rover at nasa Space suit because you have to pick the right suit for the environment
- By allowing us to be in the moment and feel like we were doing the things in "real life"
- By giving us the knowledge of both

- Fun to pretend
- Having to code and plot the path for the mars rover.
- I could do something like a scientist
- I felt like I was on Mars
- I pretended I was a scientist and that I needed to not crash the rover.
- It felt like I had to program something.
- Learning knowledge of space I didn't know before
- My son could see himself as an astronaut with his face in the space suit and the picture surrounding him.
- Planet walk- it felt like I was looking at a hologram of a planet and studying it
- The activities made me feel like a NASA scientist because I could see the planets.
- The code a rover activity made the kids excited about controlling something on Mars and looked up pics of Mars to see if it would look like on the app.
- The coding for the Mars Rover and the space suit fitting were things actual astronauts have to do, so I felt like an astronaut.
- The experiment was really engaging and interesting to see. It felt like doing something related to school but was super fun.
- The spaces suit but there was a few glitches with the others, but the space suit made me feel like I was a real astronaut because I could see what I would look like, but I would say it needs better graphics
- We could see the real planet!

Appendix E: Instruments

DIY App based activities: Survey Questions

1) Overall, how much did the app connect to human space exploration?

- Not at all
 A little
 Somewhat
 A lot

2) Overall, did you learn anything new about space exploration from using the app?

- No
 Yes
 Not sure

2b) [if yes] What are 1 or 2 things you learned about?

3) How much has your interest in learning about human space exploration and NASA's return to the moon increased after using the app?

- Not at all
 A little
 Somewhat
 A lot

3b) What about the activities made you want to learn more?

4) What are 1 or 2 things about human space exploration or NASA missions that you are curious about after using the app?

5) While doing the activities, was there anything you were wondering about or places you wanted more information?

1) How would you rate your agreement with the following statements?

	Strongly disagree	Disagree	Agree	Strongly agree
I am interested in space exploration.				
I am knowledgeable about space exploration.				
I am excited to learn more about human space exploration.				

I consider myself a 'science person'.				
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2) Thinking back to BEFORE using the app, how would you rate your agreement with the following statements?

	Strongly disagree	Disagree	Agree	Strongly agree
I am interested in space exploration.				
I am knowledgeable about space exploration.				
I am excited to learn more about human space exploration.				
I consider myself a 'science person'.				

These next questions will help us understand a little bit more about your experience with the specific activities.

3) How interesting was each activity?

	Not interesting	A little interesting	Interesting	Very interesting	Did not experience
Breath of fresh air					
Design a space souvenir					
Ice orb					
Pack your bags					
Solar system trek					
Space garden					
Moon suit					
Code a Mars rover					
Planet walk					

4) How enjoyable was each activity?

	Not enjoyable	A little enjoyable	Enjoyable	Very enjoyable	Did not experience
Breath of fresh air					
Design a space souvenir					
Ice orb					
Pack your bags					
Solar system trek					
Space garden					
Moon suit					
Code a Mars rover					
Planet walk					

5) How much did each activity connect to your daily life?

	Not at all	A little	Some	A lot	Did not experience
Breath of fresh air					
Design a space souvenir					
Ice orb					
Pack your bags					
Solar system trek					
Space garden					
Moon suit					
Code a Mars rover					
Planet walk					

1) How did the activities remind you of your daily life?

2) When doing the virtual activities (*list them here*) , did you feel like a NASA astronaut or scientist?

- No
 Yes
 Not sure

2b) [if yes] How did the activity make you feel like a NASA astronaut or scientist?

3) We'd like an opportunity to talk about your experience in more depth. We are offering an additional \$25 VISA gift card to groups who participate in a no-more-than-1-hr video interview. The interview would occur sometime between January and March, and would be scheduled based on your household's preferences.

Would you and your child be interested in participating in a virtual follow up interview about the DIY app?

Yes/No

4) What are the ages and gender identities of the people in your group who used the app?

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

DIY App based activities: Interview Questions

1. First, can you tell us what activities your group did? We sent materials for [activities] but we know you maybe did other ones on the app.

- Breath of fresh air
- Design a space souvenir
- Ice orb
- Pack your bags
- Solar system trek
- Space garden
- Moon Suit
- Code a Mars Rover
- Planet walk

2. Overall, how enjoyable were the activities that you did?

- a. [Specific activities- Follow up based on survey responses, go through the different activities they did] What did you like about them? Why did you give those ratings?
3. Overall, how interesting were the activities that you did?
 - a. [Specific activities – Follow up based on survey responses, go through the different activities they did] What did you like about them? Why did you give those ratings?
4. In the survey, you mentioned learning [XYZ]. Can you tell us a little more about that?
 - a. What are some of the new things you learned about human space exploration from doing the activities?
 - b. How did the activity help you learn about [XYZ]?
 - c. Did you learn anything new about science or engineering more broadly?
5. What are some of the questions or things you are curious about after doing the different activities?
6. How did the activities connect to your daily life?
 - a. In what ways were they relevant to you?
 - b. [Probe] Had your family talked about human space exploration or NASA’s return to the moon before? How did these activities fit within those conversations?
7. [Follow up based on survey responses to behavior change]
 - a. EX: It looks like you weren’t very interested in space exploration before, but then afterwards said you were very interested. Can you tell me more about why that changed? What about the activity (or activities) that piqued your interest?
8. We’re also interested to learn about how groups actually use the app. Did you do anything differently than the app said or make any changes to make things more usable?
 - a. [Probe] Why did you do things that way?
 - b. Did you do any experimenting or trying things differently?
9. Can you tell us a little bit more about how your group did the activities? For example, did you do all the activities at one time? Or spread out over a longer time period?
 - a. Did you do things multiple times?
10. When you were using the app, who all was participating?
 - a. Was it the whole family every time, just a few folks, etc.)

Museum Based activities: Observation sheet

VOYAGE THROUGH THE SOLAR SYSTEM: KIT ACTIVITY OBSERVATION

Case #: _____ Data collector: _____ Location: Bakken Bell

Activity (circle): BOF MB SM Date: _____ Group Size: _____

	Younger than 8	8 - 14 years old	15-18 years old	Adults
Number in group				

Behavior	Number of times observed	Narrative
Discuss human space exploration or NASA		
Be curious or ask questions		
Make a personal connection		
Hypothesize or wonder out loud		
Problem solve (test, iterate, etc.)		
Miscellaneous behaviors		

Challenges observed:

Quote-able quotes:

Museum Based activities: Survey questions

1) Overall, how **interesting** was the activity?

- Not interesting interesting A little interesting Interesting Very interesting

2) Overall, how **enjoyable** was the activity?

- Not enjoyable enjoyable A little enjoyable Enjoyable Very enjoyable

3) How much did the activity connect to human space exploration?

- Not at all A little Somewhat A lot

4) Did you learn anything new about space exploration from participating in the activity?

- No Yes Not sure

4b) [if yes] What are 1 or 2 things you learned about?

5) How much has your interest in learning about human space exploration and NASA's return to the moon increased after doing this activity?

- Not at all A little Somewhat A lot

5b) What about this activity made you want to learn more?

6) What are 1 or 2 things about human space exploration or NASA missions that you are curious about after doing this activity?

7) What in your daily life connects to something you learned or did in this activity?

For these next questions, we want to hear about your own experiences after participating in the activity.

7) How would you rate your agreement with the following statements?

	Strongly disagree	Disagree	Agree	Strongly agree
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I am interested in space exploration.				
I am knowledgeable about space exploration.				
I am excited to learn more about human space exploration.				
I consider myself a 'science person'.				

8) Thinking back to BEFORE doing the activity, how would you rate your agreement with the following statements?

	Strongly disagree	Disagree	Agree	Strongly agree
I am interested in space exploration.				
I am knowledgeable about space exploration.				
I am excited to learn more about human space exploration.				
I consider myself a 'science person'.				

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										