Space and Earth Informal STEM Education (SEISE) Project Professional Impacts Summative Evaluation

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NISE NATIONAL INFORMAL STEM EDUCATION NETWORK

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Professionals attending the 2019 NISE Network Earth & Space Partner Meeting. (Photo by Emily Maletz)

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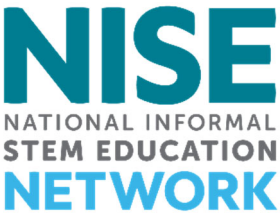

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Space and Earth Informal STEM Education Project
Summative Evaluations Executive Summary

The NISE Network Space and Earth Informal STEM Education (SEISE) project was funded through the National Aeronautics and Space Administration (NASA)'s Science Mission Directorate (SMD) Science Activation program. The National Informal STEM Education Network (NISE Network) is a community of informal educators and scientists dedicated to supporting learning about science, technology, engineering, and math (STEM) across the United States; overall 513 NISE Network partner organizations participated in the SEISE project between 2015 and 2020.

Evaluating the impact of the project

Evaluations were focused on understanding the overall impacts of the SEISE project on professionals' Earth and space work, as well as the impacts of SEISE products on the public's interest, engagement, relevance, and understanding of SMD content areas (Earth science, heliophysics, planetary science, astrophysics). More information about the three summative evaluation studies and the methods they employed can be found in the accompanying reports on nisenet.org/evaluation/summative-evaluation-reports.

Project deliverables

Explore Science: Earth & Space toolkits

comprised of engaging, hands-on Earth and space science experiences with connections to science, technology, and society.

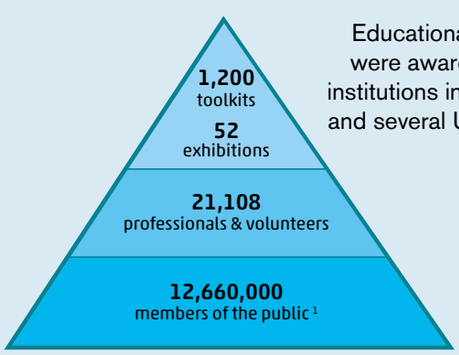
Sun, Earth, Universe exhibition

offered engineering activities, games, and graphics that allowed visitors to engage in fun interactive Earth and space science experiences, while using skills essential to STEM learning.

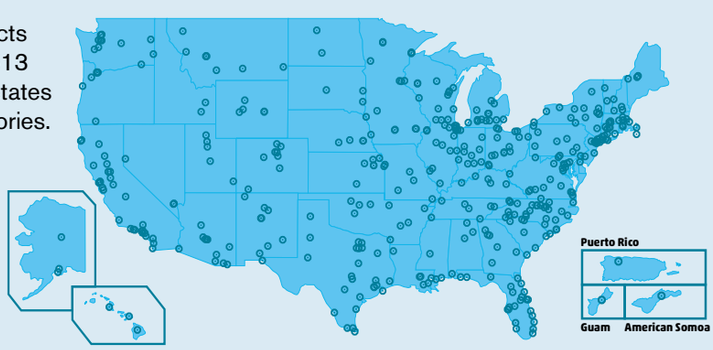
Professional development

included 43 Online Workshops, an in-person Earth & Space Partner Meeting in 2019, as well as training resources and materials to help professionals engage the public.

By the end of 2020, the NISE Network SEISE project had reached millions of public participants and thousands of professionals in urban and rural areas.



Educational products were awarded to 513 institutions in all 50 states and several US territories.



[1]Anderson, A. (2021). *Public reach estimates for the SEISE project.* Boston, MA: Museum of Science, Boston for the NISE Network.

This material is based upon work supported by NASA under cooperative agreement award numbers NNX16AC67A and 80NSSC18M0061. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the view of the National Aeronautics and Space Administration (NASA).

SEISE Project Professional Impacts Evaluation

The professional impacts evaluation was a longitudinal study focused on professionals' content understanding, use of SEISE products, public engagement practices, and partnerships with respect to Earth and space science. This executive summary highlights the main findings from surveys and interviews.

Knowledge of Earth and space topics and use of products

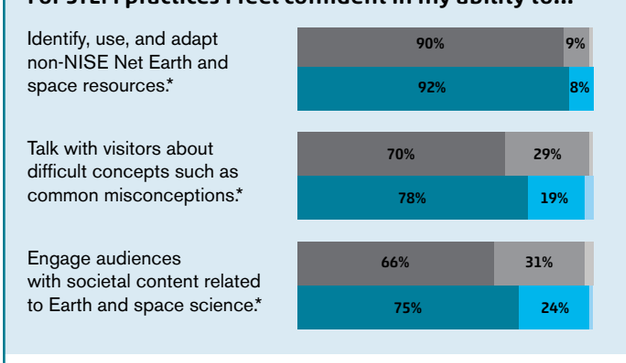
Professionals' confidence in facilitating the Earth and space content areas significantly increased with their involvement in the project and most reported using SEISE materials for presenting all content areas.

All partner institutions used their toolkit beyond the required event. Toolkits were most frequently used for brief table top activities and K-12 school outreach.

Impact on informal STEM practices and parterships

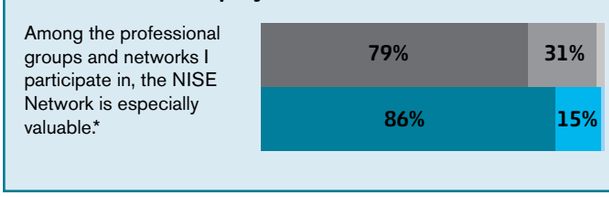
The SEISE project has significantly increased partners' confidence in their ability to address societal content, discuss common misconceptions, and use non-NISE Network materials for Earth and space.

For STEM practices I feel confident in my ability to...



Items marked with an asterisk (*) indicate statistically significant change.

Value of the SEISE project



93% of professionals collaborate with community organizations and/or subject matter experts

91% Community collaborations

83% Subject matter expert collaborations

Professionals shared that the project helped enhance their Earth and space partnerships through activity materials and training resources.

> *"The biggest thing is being able to share that resource of how to actually interact with guests and share knowledge . . . being able to share that with our industry partners has just made it much easier for them to feel comfortable and confident being part of the program because it gives them that support and that piece that they can learn from."*
>
> *-a museum professional*

Value of the SEISE project to professionals

Overall, professionals valued the opportunities offered by the project and showed significant growth in being able to meet, learn from, or share with others.

> *"When I went to the conference in Phoenix that opened my eyes to the other ways that we could be expanding the use of the NISE kits and hearing what other people were doing really helps me come home and rethink how we can use ours."*
>
> *-a museum professional*

NISE NATIONAL INFORMAL STEM EDUCATION NETWORK

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1. Introduction

1.1 Project overview

The National Informal STEM Education Network (NISE Network) is a community of informal educators and scientists who are dedicated to supporting learning about science, technology, engineering, and math (STEM) across the United States. The NISE Network aims to build the capacity of informal science education institutions and research organizations to work together to raise public awareness, understanding, and engagement with current topics in science. In 2015, the NISE Network was awarded funding from the National Aeronautics and Space Administration (NASA) to create educational products and support informal educators' professional development in engaging the public with Earth and space content (through cooperative agreements NNX16AC67A and 80NSSC18M0061). Through this funding, the Space and Earth Informal STEM Education (SEISE) project created numerous professional development opportunities for informal educators, including in-person professional development, online workshops, and resources and materials. In addition, SEISE created over 1,200 activity toolkits for distribution to partners, and 52 copies of the 600 ft^2 *Sun, Earth, Universe* exhibition that have been awarded to science centers, children's museums, and other locations all across the United States, such as nature centers and libraries.

1.2 Summary of SEISE professional development offerings

Over the course of the five-year NASA grant, SEISE offered a range of free professional development opportunities and resources to support informal educators' ability to offer Earth and space programming and to partner with others for this work. SEISE professional development opportunities included an in-person meeting and online workshops. Resources were also created to support professionals' use of the toolkits, the exhibition, and their work with the public. Below is an overview of each type of offering.

1.2.1 Professional development opportunities

- **In-person professional development** occurred through the NISE Network Earth & Space Partner Meeting held in February of 2019 in Tempe, AZ. Almost 300 professionals from across the country were invited to participate in over 2 days of plenaries, concurrent sessions, a NASA Science Activation showcase, Earth & space science technical talks, and networking opportunities.[1]

Images [left to right]: Group photo from the 2019 Partner Meeting in Tempe, AZ; Conversation during the NASA showcase; Jim Bell (ASU) during a keynote presentation.

[1] More information about the NISE Network Earth & Space Partner Meeting 2019 can be found on the NISE Network website: www.nisenet.org/2019-partner-meeting

- **Online workshops** connected with the SEISE project have been offered from September 2016-November 2020. These professional development opportunities have included a four-week workshop in 2017 that was focused on how to prepare educators to present toolkit activities to public audiences as well as 43 different hour-long workshops. The hour-long workshops have brought together SEISE professional partners and experts to share their expertise and experiences on a vast array of topics ranging from special event programming related to Earth and space, to the science behind the SEISE toolkits, to innovative ways to use SEISE materials with various audiences and partners. See Appendix A: Online Workshops for a list of the 43 titles.[2]

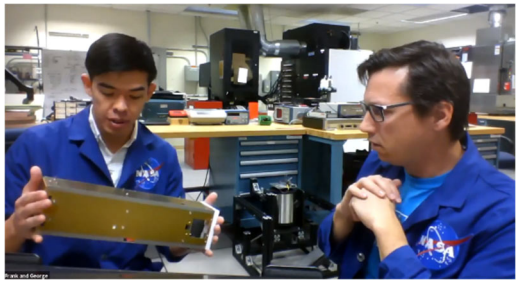


Image: George Gorospe gives a virtual tour of his lab at NASA Ames Research Center during an online workshop.

1.2.2. Professional development resources

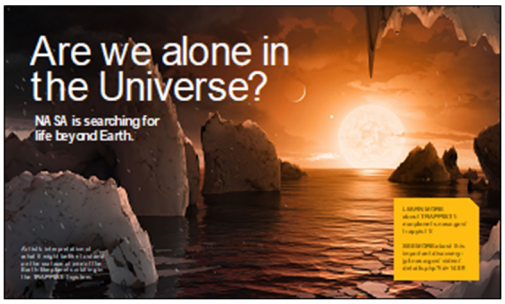
- **Public engagement resources** produced throughout the SEISE project have included four *Explore Science: Earth & Space* toolkits each comprised of 9 to 16 hands-on Earth and space science activities. These free, physical toolkits have been sent to 513 partner institutions across the United States, with all of the digital materials available online. Each toolkit activity was aligned with specific Earth and space content and aspect(s) of the Network's learning framework. Appendix B shows the content and learning frameworks used by the project team, while Appendix C provides information on the activities and matches the activities to the frameworks. In addition, SEISE has created the *Sun, Earth, Universe* exhibition which allows visitors to engage in fun interactive Earth and space science experiences using skills essential to STEM learning that are critical to the work of NASA in advancing new discoveries about our Earth, Sun, solar system, and universe. Both the toolkits and the *Sun, Earth, Universe* exhibition are bilingual in English and Spanish.[3]

[2] All of the SEISE project's online workshops are recorded and archived on the NISE Network website, along with online workshops from other NISE Net projects. They can be found through the following link. www.nisenet.org/online-workshop-recordings.

[3] Visit the NISE Network website to learn more about the public engagement and professional development resources included in the *Explore Science: Earth & Space* toolkits (www.nisenet.org/earthspacekit) and the *Sun, Earth, Universe* exhibition (www.nisenet.org/sunearthuniverse).

Images [left to right]: A photo of the Sun, Earth, Universe exhibition; Visitors using the "Exploring Earth: Paper Mountains" toolkit activity.

- **Toolkit and exhibition supporting resources** were developed by the SEISE project to support professionals' practice and learning. The toolkits included facilitation guides, background content information, and training videos for each hands-on activity. The exhibition has an accompanying museum educator guide, school field trip guides and worksheets, promotional and marketing materials, as well as information on the development process. Other resources included useful information for engaging audiences in Earth and space science content, such as event planning and collaboration guides, as well as more written guides, tip sheets, and videos for general facilitation and public engagement.[4]



Images [left to right]: Educator demonstrating how to talk about difficult concepts in one of the "Explore Science: Earth & Space Strategies for Addressing Common Misconceptions Videos"; Information sheet to support the "Explore the Universe: Imagining Life" activity.

- **Additional resources:** The SEISE project sent out monthly newsletters that shared partner highlights, upcoming opportunities and events, and relevant news articles. Regional hub leaders also communicated and shared resources directly with museum partners.

[4] Training videos for the *Explore Science: Earth & Space* activities are archived online at: vimeo.com/showcase/4249834. One example of the many supporting resources is a basic tips sheet for running any of the toolkit activities; the "Explore Science: Tips for leading hands-on activities" can be found on the NISE Network website here: www.nisenet.org/catalog/explore-science-tips-leading-hands-activities

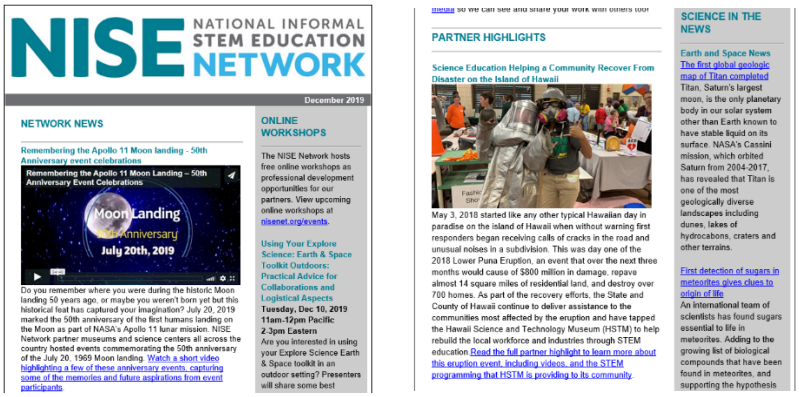


Image: Excerpts from the December 2019 NISE Network Newsletter.

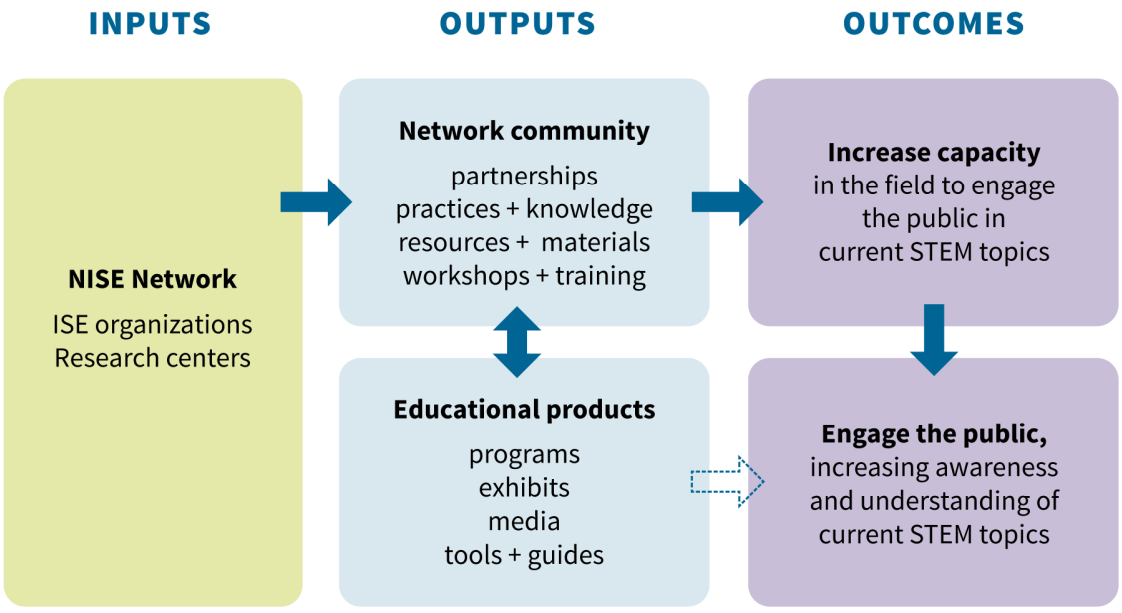
1.3 Evaluation questions

The SEISE Project Professional Impacts Summative Evaluation was a longitudinal study focused on professionals taking part in Years 1-5 of SEISE. Because the primary professional goals of SEISE were to increase the use of best practices by informal science educators (ISE) related to Earth and space content and to foster relationships and collaborations between different organizations, the evaluation aimed to understand how professionals were impacted in these areas. Specific evaluation questions guiding this study included:

1) **How many professionals does the SEISE project reach, and how do they feel about the Network community?**
2) **What kinds of partnerships are formed between professionals during SEISE?**
3) **How does SEISE impact professionals' knowledge and understanding of Earth and space content areas?**
4) **How does SEISE impact professionals' use of the project's public-facing products and their implementation of practices for engaging the public?**

This evaluation study was grounded in the NISE Network's logic model, which is depicted in Figure 1. Overall, the Network's theory of action emphasizes how the community and educational products created by the Network can lead to professional and public impacts. Specifically, by increasing the capacity of the field and professionals to deliver Earth and space programming, the Network can help achieve the public outcomes of the SEISE project. As can be seen in the logic model, the Network advances professionals' knowledge and practices through professional development opportunities and supports created for the public-facing activities and exhibits produced by the Network.

Figure 1: The NISE Network's simplified logic model



1.4 Study timing and COVID-19-related changes

The SEISE professional impacts evaluation occurred during Years 1-5 (2016-2020) of the SEISE project. For the first year of the project, the professional impacts evaluators contributed to the literature review of past evaluation reports related to Earth and space informal science learning experiences to help inform the project team's initial product development (King et al., 2016). During Years 2-5, data were gathered for this study through a series of surveys, to longitudinally track professionals' content understanding and public engagement practices with respect to Earth and space science and their use of SEISE products. In addition to surveys, in-depth interviews were conducted in Years 4-5 with a small cohort of professionals taking part in SEISE. See Table 1 for an overview of the evaluation study timeline and major milestones.

Additional details about the data collection efforts used in this study will be covered in Section 2: Methods; however, it is important to note that the study's plans were affected by the COVID-19 pandemic in 2020. Due to the virus's drastic impacts on informal science education activities throughout the spring and summer of 2020, the fourth and final survey distribution was no longer appropriate. The disruptions to programming and museum operations caused by the pandemic meant that it did not make sense to continue with the same survey to track changes in use, knowledge, and partnering. Instead, a separate survey asking about the impacts of COVID-19 and how professionals may have used SEISE materials during 2019-2020, including new and unanticipated ways, was conducted in the fall of 2020. Because these data were not included in the longitudinal study, findings related to partners' experiences with SEISE during COVID are summarized in an addendum to this report.

The in-depth interviews were also impacted by COVID-19. While the study had planned to interview a second cohort of professionals participating in SEISE during the summer of 2020, the decision was made to instead focus on following up with the initial cohort of interviewees. Evaluators changed plans because the virus had a severe impact on professional resources at informal science education institutions, and the mass layoffs and furloughs happening in the field would have made it difficult to recruit new professionals. The follow-up interviews that did

occur with the existing participants during the summer of 2020 still allowed for a longitudinal understanding of partners' experiences and provided additional information about the effects of COVID-19 on their work. Insights from this second round of interviews related to pre-COVID impacts are used throughout the report to support the longitudinal findings, while COVID specific data can be found in Section 10: COVID-19 addendum.

Table 1: *Major milestones for the SEISE Project Professional Impacts Study*

	Year 1 (2016)				Year 2 (2017)				Year 3 (2018)				Year 4 (2019)				Year 5 (2020)			
Literature Review	X	X																		
Baseline Survey					X								X							
Annual Partner Survey								X				X				X			X	
Interviews															X		*	X		

*Widespread impacts of COVID-19 began in March 2020

2. Methods

The subjects of this evaluation were professionals in the ISE field who were involved in the SEISE project either by receiving materials or participating in professional development opportunities. Primarily, data collection for the SEISE Project Professional Impacts Summative Evaluation included online surveys and interviews. Data were collected through two baseline surveys (2017 and 2019) and three annual partner surveys (2017, 2018, and 2019). Additionally, a small group of professionals participated in a set of two interviews, providing qualitative data to compliment the surveys. Together these data allowed for a longitudinal view of professionals' experiences in SEISE. A fourth annual partner survey was sent out in 2020 to understand how the pandemic affected professionals' Earth and space science education efforts; methods and results for this survey are included as an addendum to this report, see Section 9: COVID-19 addendum. Data related to the reach of the SEISE project were collected through an annual kit report required of all toolkit awardees.[5] Further details about the evaluation methods and the data analysis are described below. A visual timeline of the study's milestones can be found in Section 1.4, above. Throughout the project, preliminary results were shared with project leadership to determine whether they wanted to make any changes to professional development experiences. Additionally, the evaluation team utilized a committee of visitors (COV), an external evaluation expert who provided a check on methods, plans, and findings.

2.1 Data collection

2.1.1 Baseline and Annual Partner Surveys

Five surveys were sent out at regular intervals throughout the study to understand professionals' confidence around their content knowledge, the extent to which they used NASA resources, and how they partnered with others around Earth and space science. Details about the specific surveys and recruitment methods are explained below, along with an overview of the adjustments made due to the COVID-19 pandemic.

Baseline surveys were sent to professionals at the beginning of their involvement with the SEISE project in order to gauge a sense of their Earth and space offerings and confidence in their ability to facilitate Earth and space science experiences, before they began using SEISE products. One survey was sent in 2017 (Baseline 2017), as kits were first being distributed to partner organizations. When the project expanded from providing kits for 250 institutions to 350 institutions, new partners were also invited to take a baseline survey (2019 Baseline), to capture similar insight about this group. The instrument used for the 2019 Baseline is included in Appendix D: Instruments.

Annual partner surveys (APS) were distributed in 2017, 2018, and 2019, to provide an update on individuals' offerings and learnings or to serve as an initial baseline for new study participants. In addition to questions from the baseline surveys, each APS also included questions about professionals' use of SEISE products, use of practices encouraged by SEISE, Earth and space content knowledge and collaborations, sense of community in regards to the Network, and impacts of the SEISE materials . These surveys were also used to collect data about notable Earth and space science events such as the 2017 solar eclipse or 2019 Apollo 50th anniversary celebrations. Instruments for the 2019 APS can be found in Appendix D: Instruments.

The surveys were all conducted online and were estimated to take between 10 and 30 minutes to complete, depending on the survey. Each survey was promoted through NISE Network newsletters and online workshops. Invited participants were sent up to three email reminders.

[5] Details about public reach are discussed in a separate memo: Anderson, A. (2021). Public reach estimates for the SEISE project. Boston, MA: Museum of Science, Boston for the NISE Network.

As an incentive to complete the survey, participants were automatically entered into a raffle to potentially win one of several bundles of Earth & space science educational materials.

A fourth and final APS was planned for the fall of 2020 in order to continue to understand individuals' experiences in SEISE and how partners had presented Earth and space science content to their audiences over the last year. As described in Section 1.4, the extensive impacts of the COVID-19 pandemic on informal science education activities throughout the spring and summer of 2020 made this survey in its standard form no longer appropriate. Thus, the 2019 APS is the final longitudinal piece of quantitative data for this study. However, a shorter survey was sent out in the fall of 2020 that focused on the impacts of the COVID-19 pandemic on partners' Earth and space education efforts and their perceptions of the Network during this time. The instrument for the 2020 COVID APS can be found in Appendix D: Instruments.

2.1.2 Baseline and Annual Partner Survey recruitment and sampling

Surveys were sent to SEISE contacts in active organizational or individual involvement categories defined by the Network. Organizational involvement included people who were primary contacts at institutions that had received at least one *Explore Science: Earth & Space* physical toolkit or the *Sun, Earth, Universe* exhibition. Individual involvement included recruiting people who participated in at least one SEISE-related online workshop, were enrolled in the four-week professional development online workshop series in 2017, or attended the national Partner Meeting in 2019. For individuals who were recruited to participate in the evaluation, their involvement ranged from minimal use of SEISE resources to being connected with the project in multiple ways. In practice, this ranged from someone who had only attended an online workshop to someone who had all of the kits, the exhibit, and had participated in multiple professional development experiences. In this report, "professionals" are those people who were eligible for the study, as defined in this paragraph.

For each survey, the evaluation team purposefully did not include certain individuals. People who had strong connections with NASA (e.g. Solar System ambassadors) or were subject matter experts (SME) were not included because they were often only involved in advisory roles or connected to SEISE through other Science Activation projects. The only exceptions were individuals in these categories who were also affiliated with an institution that received a toolkit or exhibition. Additionally, individuals who had previously taken a survey but were no longer at their institutions were not subsequently included. Since physical toolkits from the Network were awarded only to museums, public planetariums, and university outreach programs located in the United States, the sample was limited to US-based individuals.

The two baseline surveys had additional recruitment parameters beyond the eligibility requirements above. The 2017 Baseline reached out to partners who had expressed an early interest in SEISE and would be eligible for materials in the future. A snowball sampling technique was also employed in order to reach as many ISE professionals working with Earth and space science content as possible. For this type of recruitment, survey participants were asked to provide e-mail addresses of any additional colleagues at their institution who would be most likely to use the *Explore Science: Earth & Space* toolkit materials provided by SEISE or who currently engaged public audiences in Earth and space science. The 2019 Baseline was created to learn about professionals who were new to the Network, after the total number of kits awarded was expanded from 250 to 350 that year, so the survey was sent only to contacts at these new institutions.

Based on these criteria, the list of individuals reached out to for each survey ranged from 589 contacts in the first year to 1481 contacts in the final year. Over the course of the project, the number of responses varied by survey, from 62 (2019 Baseline) to 256 (2019 APS). See Table 2 for details about each of the surveys, including sample sizes and response rates. Professionals' participation was tracked throughout the study to allow for longitudinal comparisons. In total,

588 unique individuals participated in the SEISE Project Professional Impacts Summative Evaluation.

Table 2. *Baseline and annual partner survey details*

Survey	Survey dates	Sample size	Response rate[6]
2017 Baseline	February 13 – March 14, 2017	182	31%
2017 Annual partner survey	November 29 – December 22, 2017	111	23%
2018 Annual partner survey	November 11 – December 5, 2018	161	19%
2019 Baseline	January 25 – February 14, 2019	62	46%
2019 Annual partner survey	November 6 – December 11, 2019	256	21%
2020 COVID Annual partner survey	October 9 – October 25 , 2020	192	14%

2.1.3 Survey respondent description

As part of each survey recruitment wave, data about respondents were downloaded from the NISE Network Quickbase database to provide a sense of who the participants were. These data focused on professionals' involvement with the SEISE project as well as institutional demographics. The number of materials awarded or workshops attended that are captured in this description reflects professionals' involvement at the time of their last survey. Overall, professionals who responded to the survey ended up being the partners who were most involved in the SEISE project. When compared to all professionals contacted through survey recruitment, those who responded to the survey were more likely to be at institutions that had toolkits or the exhibition. They also were more likely to have gone to a higher number of workshops. However, participants in the SEISE Project Professional Impacts Summative Evaluation were associated with a wide diversity of organization sizes, locations, and types. A more detailed description of the professionals who are included in each data set comprising the sample can be found in Appendix E: Respondent Description.

2.1.4 Interviews

Interviews were conducted with a small set of professionals across the last two years of the study. The first round of interviews, in September and October 2019, allowed for a deeper understanding of participants' responses from their most recent survey, either baseline or APS, and provided additional information about impacts of the SEISE project. Overall, during the first interview, participants were asked about their:

- Personal and institutional connections to the SEISE project;
- Knowledge and understanding of Earth and space content areas;
- Use of SEISE-related products and informal STEM education practices;
- Earth and space related partnerships; and
- Thoughts about the NISE Network community.

The second round of interviews, in August 2020, was a follow-up on responses from the first interview and any subsequent 2019 APS participation. Questions focused on changes over the

[6] Response rate was calculated based on the total number of completed surveys divided by total number of eligible contacts. Emails that bounced or were undeliverable were removed from the initial contact list, as these people never received the invitation, thus, creating the eligible contact list.

last year in the areas outlined for the initial interview. Since the COVID-19 pandemic had created so many transformations to how museums and other ISE institutions operated during this time, the interviews also included questions about what their institutions were doing to adjust their work. Interview instruments can be found in Appendix A: Instruments.

Originally, there had been plans for the second year of interviews to include follow-ups with the first cohort and additional in-depth interviews with a new cohort. However, at the time of recruitment, many museums and other ISE institutions were in the middle of rounds of layoffs, furloughs, and otherwise disrupted work due to COVID-19. It was decided that reaching out to a new group of professionals at this moment would be inappropriate, so the second cohort was not recruited.

2.1.5 Interview recruitment and sampling

Professionals were invited to participate in the interviews if they had completed at least one survey at the time of recruitment. Overall, individuals were recruited to represent a diversity of perspectives and experiences within the Network to help contextualize the survey data, specifically in terms of:

- How many toolkits their institution had (one, two, or three);
- Whether or not they had the *Sun, Earth, Universe* exhibition;
- When they became involved in the SEISE project (2017 or 2019); and
- What type of institution they worked at (children's museums, science museums, or planetariums).

Participants were recruited over email and ahead of the interview sent a short reminder with definitions from the APS that would be referred to during the conversation. Interviews were conducted either over the phone or over video call, with audio recordings being made for later transcription purposes so that the team could accurately capture their responses. The first interview took one hour, while the second round was about 30 minutes long. Incentives were provided in the form of a $25 Amazon gift card for each interview. Overall, 13 professionals participated in the interviews, and only one individual dropped out in the second year.

2.1.6 Toolkit reports

Another method used as part of this study was the Network's toolkit reports. Each year, institutions awarded an *Explore Science: Earth and Space* toolkit were required to fill out a kit report with information about their institution, the kinds of events they hosted, and how the toolkit materials were used. Two questions from this report were employed as part of the SEISE Project Professional Impacts Summative Evaluation, to help understand professional reach and toolkit usage. Thus, the reach numbers highlighted in this study include the number of volunteers from the toolkit reports combined with the number of professionals invited to participate in the study's five surveys. The findings about professionals' product usage also draw from a question on the toolkit reports, where institutions shared how often they used kit materials for various formats.[7]

2.2 Data analysis

The SEISE Project Professional Impacts Summative Evaluation utilized mixed methods, drawing on both quantitative and qualitative analyses. Findings in this report are from three

[7] The question around toolkit use was employed to understand both professionals' use of the kits and to calculate public reach. While this question was initially asked on the first APS, it was moved to the required toolkit report due to low representation of kit recipients participating in the 2017 APS (86 of 250 institutions).

primary data sets (longitudinal sample, 2019 APS, and interviews; see Table 3 for sample sizes), with tables and figures labeled accordingly. The longitudinal sample (N=178) focused on looking for change over time using inferential statistics, comparing data from professionals who completed at least two surveys between 2017 and 2019, from the five surveys that occurred during this timeframe listed in Table 2. Data from the 2019 APS (N=256) that are included in this report represent final descriptive data and self-reported impacts, which were analyzed quantitatively through descriptive frequencies. Interviews (N=13) provided a qualitative understanding of the quantitative data and offered a rich description of professionals' experience with the SEISE project. Findings related to the impact of the pandemic are included in Section 10: COVID-19 addendum to this report. Data related to the pandemic are reported through descriptive frequencies and qualitative analyses.

Table 3. *Analyzed data sets referred to in this report*

Data Source	Sample Size
Longitudinal (paired pre/post annual partner surveys)	178
2019 Annual Partner Survey	256
Interviews	13[8]

2.2.1 Quantitative analysis of survey data

This study focused on changes that occurred during professionals' involvement with the SEISE project. A longitudinal sample was made up of professionals who completed at least two surveys, in any combination, so that they would have a first survey and a last survey. Over the course of the project, a total of 178 partners completed at least two surveys reflecting a range of involvement with and use of SEISE resources and professional development opportunities. The breakdown of when partners' first and last surveys occurred is shown in Table 4.

Table 4. *Timing of first and last survey responses for longitudinal sample, N=178*

		Last Response		
		2017 APS	2018 APS	2019 APS
First Response	2017 Baseline	11% (20)	13% (23)	27% (49)
	2017 APS		3% (5)	10% (18)
	2018 APS			21% (37)
	2019 Baseline			15% (26)

Comparisons were made between professionals' first and last survey responses using inferential statistical tests. Because all data were negatively skewed, non-parametric tests were employed.

[8] The 2020 round had a total of 12 interviews.

Throughout the report, statistically significant data ($p < 0.05$) are marked with asterisks (*), additional supporting data including significance (p=) and effect size (r=) can be found in the footnotes.

Some questions included in the longitudinal analysis asked participants to rate their agreement on a ten-point scale, from "completely disagree" (1) to "completely agree" (10) or from "not at all" (1) to "a great deal" (10). For ease of interpretation, ratings are grouped into high (8-10), medium (5-7), and low (1-4) categories for charts and discussion in this report. These ordinal data (and other Likert-type questions) were analyzed using the Wilcoxon signed ranks test. Additionally, effect sizes were calculated to determine the magnitude of change, or strength of the finding, for statistically significant results. The calculation $r=Z/\sqrt{n}$ was used to evaluate the effect size as small (<0.3), medium (0.3-0.5), or large (>0.5) (Rosenthal, 1991). Other questions included in the longitudinal analysis were dichotomous, i.e., "yes" or "no" questions, for which the McNemar's test was used. Although participants usually had a "not applicable "or "I don't know" option available, these responses were removed for analysis as they would not allow for clear conclusions about whether any change had occurred (e.g., if someone changed from "I don't know" to "yes").

In addition to the statistical analysis of the longitudinal sample, throughout this report results from the 2019 APS (N=256) are included as a snapshot of the Network as a whole at the end of the project. These findings are presented through descriptive frequencies. Questions reported in this way include those directly asking about how much the NISE Network impacted professionals in certain areas, as well as questions where a more descriptive understanding was appropriate when no changes were observed (e.g. partnerships).

2.2.2 Qualitative analysis of interviews

The interviews provided rich, qualitative data related to professionals' experiences participating in the SEISE project. Responses were analyzed through both deductive and inductive coding methods, using NVivo software. Inductive coding involves "immersion in the details and specifics of data to discover important patterns, themes, and interrelationships" (Patton, 2002). Deductive coding involves looking for themes related to the evaluation questions (Fereday & Muir-Cochrane, 2006), thus, for this project responses were grouped into categories such as "partnerships" or "use of SEISE materials." These deductive categories were then further refined through inductive coding, with evaluators looking for emergent patterns within the responses. The evaluation team systematically documented their coding, had conversations around the emerging themes, and reviewed each other's summaries. Findings from these qualitative analyses were used to either support, explain, or describe the quantitative survey results.

2.3 Data limitations

2.3.1 Accuracy of Quickbase database in creating the contact lists

Efforts were made each year by regional representatives to update the database to the best of their abilities in advance of creating the contact list for the study's surveys. However, because the Network is always changing and the contact lists were pulled from a dynamic record system, the list may still not have captured every individual currently active in the SEISE project. These variations may have been due to staff turnover, new professionals and organizations joining, or the process of manually updating the database. Nonetheless, the evaluation team considers the

Quickbase database to be the most reliable source for knowing who was involved in the Network and for gathering these contacts and associated data.[9]

2.3.2 Survey respondents' involvement in the SEISE project

Professionals with a wide range of involvement in the SEISE project, from those who had attended only one webinar to those who had received all available materials, were recruited to participate in this study. However, it is important to note that individuals who completed the surveys tended to be those who had the most involvement with the SEISE project. These people typically had toolkits, the exhibition, and/or went to multiple online workshops. While the evaluation team wanted to hear from everyone taking part in SEISE, the study is missing some of the opinions of those who were less involved in the project. Nonetheless, the evaluation team feels the findings in this report reflect the impact on the intended professional audience of the SEISE project.

[9] This language is based off limitations described in the Context Documents developed for the Nanoscale Informal Science Education Network created under the direction of Liz (Rosino) Wright from the Oregon Museum of Science and Industry. Because the Network has continued to use the Quickbase database, these points are still applicable to the SEISE project.

3. Introduction to findings

This report is the culmination of the multi-year SEISE Project Professional Impacts Summative Evaluation study that included a series of surveys and interviews with professionals to understand how the SEISE project impacted their Earth and space work. Each finding section addresses one of evaluation questions from the study:

> **Section 4:** How many professionals does the SEISE project reach, and how do they feel about the Network community?
>
> **Section 5:** What kinds of partnerships are formed between professionals during SEISE?
>
> **Section 6:** How does SEISE impact professionals' knowledge and understanding of Earth and space content areas?
>
> **Section 7:** How does SEISE impact professionals' use of the project's public-facing products and their implementation of practices for engaging the public?

Every section begins with an overview of the specific SEISE project work related to the particular area(s) covered in the evaluation question. For example, Section 4.1 provides a description of how SEISE reached professionals and the ways the project tried to create a community focused on Earth and space engagement before moving into details about the findings. To help provide a sense of the professional development opportunities available, the background information often includes summaries of relevant online workshops, in-person partner meeting sessions, and resources that were offered through SEISE. In addition to a summary of available resources, the background sections at times includes other helpful context for understanding the connections and conclusions in this report.

The findings incorporate data from the study's surveys and interviews to highlight the impacts of the project. Survey data presented through charts represent an overarching view of professionals' experience in the project, while direct quotes offer insight into individual's experiences. All of the findings are summarized in Section 8 in advance of a larger discussion about aspects of the SEISE project that helped lead to these results.

4. Findings: How many professionals does the SEISE project reach, and how do they feel about the Network community?

4.1 Background information on how the SEISE project reached professionals

The SEISE project aimed to connect with a wide variety of professionals who conduct hands-on Earth & space activities with their public audiences. In particular, SEISE offered materials and professional development to staff at children's museums, science centers, science museums, public planetariums and observatories, and NASA visitor centers in the United States. SEISE utilized the development process and the structures created for the NISE Network in order to create and distribute products and opportunities related to NASA's Science Mission Directorate (SMD). Besides developing four toolkits, an exhibition, and various resources and training videos, the SEISE project offered ways for professionals to interact with the project and further build their capacity for Earth and space informal education. Professional development included online workshops, an in-person partner meeting, and opportunities to engage with and learn from Network partners and leaders. Specifically, SEISE relied on four regional hub contacts in order to assist partner connections and work within different geographic regions of the US. SEISE also engaged professional partners through social media, conferences, and monthly newsletters. Together, these efforts contributed to the goal of enhancing professionals' ability to convey Earth & space content to public audiences while building a community of professionals focused on this topic.

4.2 Since 2017, SEISE has reached over 21,000 professionals and volunteers.

The SEISE project reached thousands of professionals and volunteers who were involved to varying degrees with engaging the public in Earth and space science. Reach was calculated using data collected through APS recruitment and annual toolkit reports, see Methods, Section 2.1. By the end of the SEISE project, the list of active SEISE-involved professionals included 1,416 contacts. In addition to these directly involved contacts, many volunteers participated in events featuring SEISE materials. Each year on the annual toolkit report, partner institutions shared the number of volunteers who were part of their required annual events. From 2017 through 2019, 19,692 volunteers were reported as supporting SEISE-related events. These volunteers included students, teachers or professors, museum or ISE professionals, Earth and space experts, and Earth and space enthusiasts. By adding these numbers together, it was calculated that the SEISE project reached at least 21,108 professionals and volunteers through professional development or public outreach experiences. Other data from this study suggest that the reach of the SEISE project was even broader. Interviewees, for example, mentioned passing along kits materials, training resources, or online workshops to other colleagues, not included in APS recruitment or involved in specific events. Together, these data highlight how the SEISE project brought together a large community of professionals and volunteers who were able to engage the public in learning about Earth and space science topics with the help of SEISE's toolkits and professional development resources.

4.3 Professionals felt significantly more connected to the Network after participating in SEISE and reported that hub leaders played a large role in making them feel welcome.

Besides wanting to grow a large network of professionals engaging the public in Earth and space experiences, the SEISE project hoped to increase professionals' sense of community within the NISE Network. Thus, as part of the APS, professionals were asked about different aspects of community connected with the SEISE project. Each year, they were asked to rate on a scale from 1-10 a series of statements about their connection to the Network, and if their needs were being met. Overall, professionals' ratings for all of the statements were higher on their last survey than their first, with over 73% of professionals strongly agreeing at the end of their participation with the seven statements. In particular, on their final survey, partners strongly agreed with the phrases "I feel like my institutional mission is being addressed by Network activities," "Among the professional groups and networks I participate in, the NISE Network is especially valuable," and "I feel I am part of the NISE Network." For all three of these statements, at least 83% of partners provided a rating of 8-10 on their final survey. See Figure 2.

Further analysis showed that after participating in SEISE professionals experienced statistically significant growth on six of the seven statements asked about on the survey.[10] These findings suggest that professionals felt a stronger sense of community after taking part in the project. While there was no statistically significant change in professionals' rating for the statement "I feel comfortable contributing to Network efforts," on the final survey 74% of professionals gave high ratings in agreement with this statement. Together these results indicate that professionals felt more connected to the Network after participating in SEISE.

In addition, on the final survey, 81% of professionals strongly agreed that they "feel like the Network and regional hub leaders in the program [made them] feel welcome." Statistical analysis further showed that the Network's hub leaders played a key role in making professionals feel connected to the Network, as this area had a large effect size, which is a strong indication of change.[11] This finding suggests that the professionals felt the hub leaders' efforts were particularly important to supporting their connection to the SEISE community.

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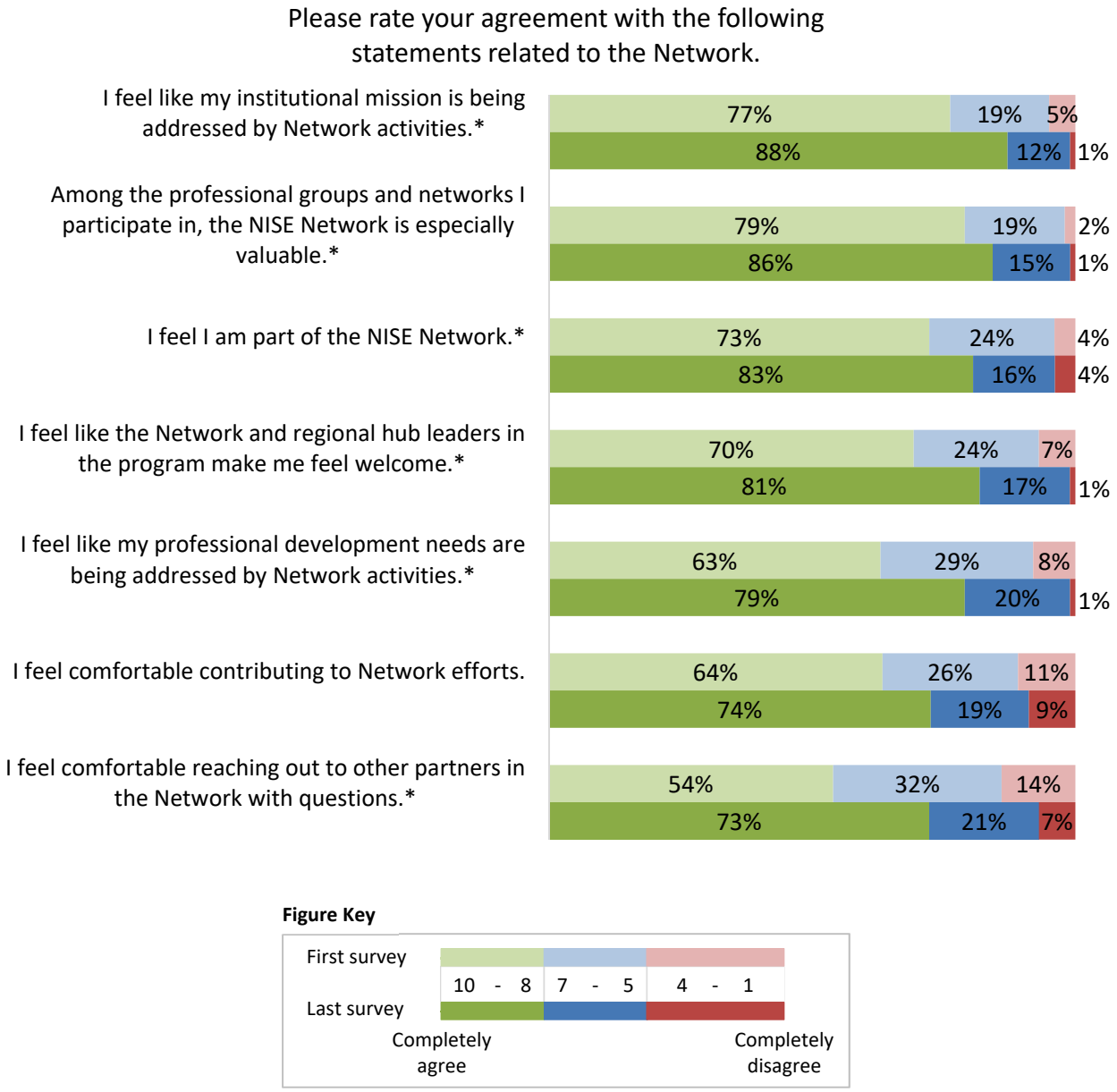
[10] "I feel I am part of the NISE Network" (p=0.006, r=0.26); "I feel comfortable reaching out to other partners in the Network with questions" (p=0.013, r=0.24); "I feel like my professional development needs are being addressed by Network activities" (p=0.049, r=0.19); "I feel like the Network and regional hub leaders in the program make me feel welcome" (p<0.000, r=0.60); "I feel like my institutional mission is being addressed by Network activities" (p=0.001, r=0.31); "Among the professional groups and networks I participate in, the NISE Network is especially valuable" (p=0.007, r=0.26).

[11] "I feel like the Network and regional hub leaders in the program make me feel welcome" (p<0.000, r=0.60)

Figure 2: *Professionals' ratings of statements about the Network community. Longitudinal analysis, n=111*[12]



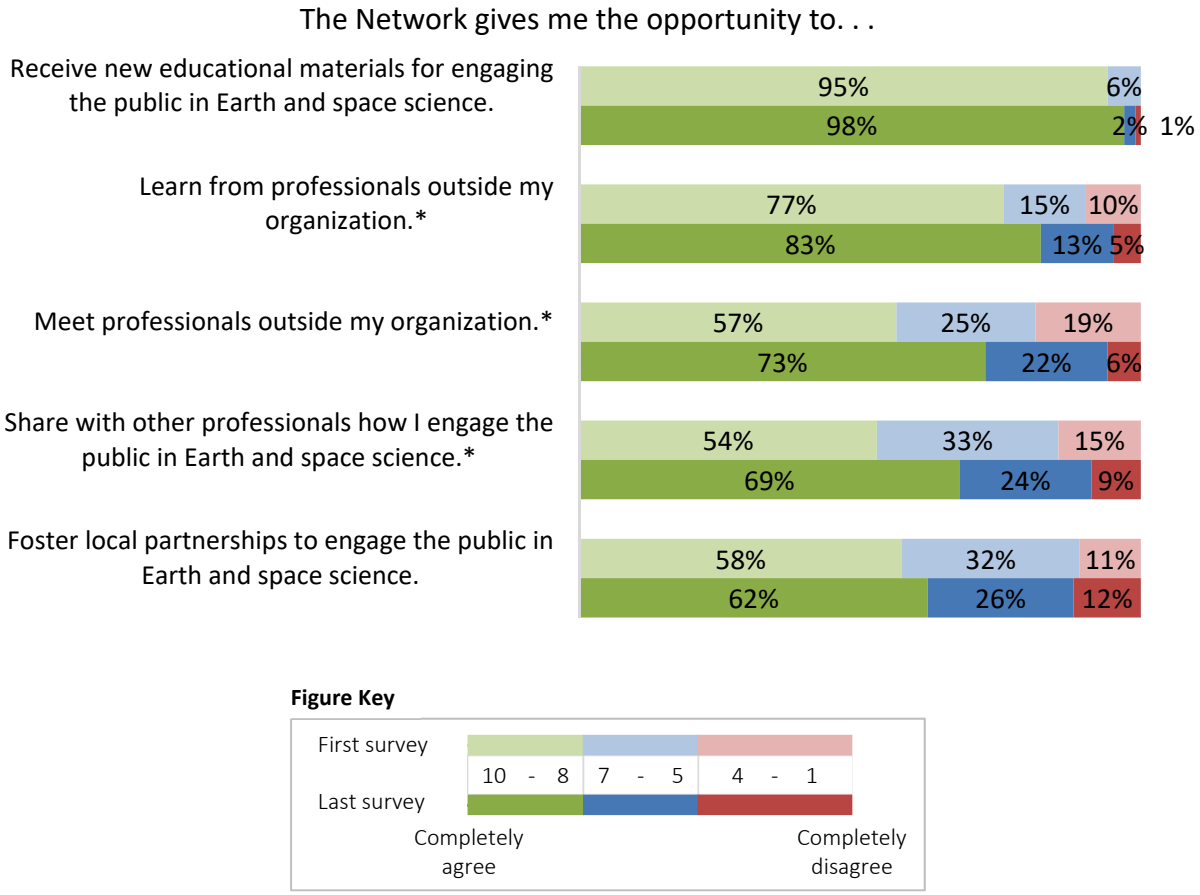
4.4 Overall, professionals valued the opportunities offered by SEISE and showed significant growth in being able to meet, learn from, or share with others.

Professionals were also asked to rate their agreement about whether or not the Network offered various opportunities. On the final survey, a majority of professionals agreed that the Network provided them with a range of options offered through the SEISE project, see Figure 3. When comparing professionals' final survey to their initial ratings, statistically significant growth was

[12] "Among the professional groups and networks I participate in, the NISE Network is especially valuable" n=110; "I feel like I am part of the NISE Network" n=112.

seen in three areas: being able to "learn from professionals outside my organization, "meet professionals outside my organization," and "share with other professionals how I engage the public in Earth and space science."[13] Although professionals did not experience statistically significant growth in terms of "receiv[ing] new educational materials for engaging the public in Earth and space science" or "foster[ing] local partnerships to engage the public in Earth and space science," 98% and 62% of professionals strongly agreed that these opportunities existed within SEISE. Moreover, data that will be discussed in Sections 5 and 7 further indicate that professionals felt SEISE offered useful materials along with support for partnerships related to Earth and space.

Figure 3: *Professionals' ratings of statements about Network opportunities. Longitudinal analysis, n=110*[14]



In addition to the results that suggest that partners felt the Network provided a variety of opportunities, data show that partners found these to be highly valuable. For each one of the statements, over 75% of professionals strongly agreed that they value these types of opportunities. Moreover, professionals experienced significant growth in how much they

[13] "Learn from professionals outside my organization" (p=0.007, r=0.26); "Meet professionals outside my organization" (p=0.001, r=0.33); "Share with other professionals how I engage the public in Earth and space science" (p=0.015, r=0.24).

[14] "Share with other professionals how I engage the public in Earth and space science" n=103; "Foster local partnerships to engage the public in Earth and space science" n=107; "Meet professionals outside my organization" n=109;

generally value "shar[ing] with other professionals how I engage the public in Earth and space science."[15] These data further suggest that professionals appreciated the efforts of the SEISE project to enhance their work in these areas.

Interview data also provided evidence to support the finding that professionals valued the various experiences offered by SEISE. Professionals discussed how the Network had provided opportunities that allowed them to meet, learn from, or share with other professionals. When describing these offerings, professionals especially noted the impact of the online workshops and the 2019 Partner Meeting. Insights from the interviews about these two opportunities are shared in the following sections.

4.4.1 Feedback about online workshops

Most of the interviewees had attended NISE Network online workshops or watched an archived recording. Almost all of the interviewees who had attended one of these online professional development opportunities felt they provided helpful background information on the toolkits and how to use them. When talking about how useful it was to hear from other professionals during the workshops, one interviewee explained,

> At this point, we feel like we're pretty comfortable in planning events and programs using the kit, and so it's more of a checking in, making sure that there's nothing else that we should be trying. It's good for us to just also keep pace and see what other organizations are doing. (#11)

A few interviewees also commented that they liked features of the online workshop format, such as the ability to get immediate answers, re-watch them later, or being able to listen and watch something as compared to reading information. Beyond talking about how they had personally grown from the online workshops, several interviewees mentioned that they had shared information about the workshops with others or that their colleagues had also benefited from the online offerings. Finally, a couple of interviewees specifically stated that the online workshops provided a sense of community. When describing this connection, one individual said,

> When we get together or we're sharing the resources and the webinars, making the connection to individuals makes it easier to reach out [and ask for more information]. . . and so the Network has been really great at opening those doors so we're not working in isolation on our subjects. (#6)

4.4.2 Reflections on the 2019 Partner Meeting

Seven of the thirteen interviewees attended the in-person Earth and Space Partner Meeting in Tempe, AZ, and all of these individuals described ways that they had been impacted by the experience. When talking about this in-person professional development opportunity, most of the interviewees explained that they had benefited by being able to learn from other participants at the meeting. In particular, interviewees emphasized that hearing how other colleagues were using the kits was useful. One individual noted,

> When I went to the conference in Phoenix that opened my eyes to the other ways that we could be expanding the use of the NISE kits and hearing what other people were doing really helps me come home and rethink how we can use ours. (#1)

Interviewees also talked about how they had learned about resources, felt more connected to the NISE Network community, or had implemented or shared something they had learned at the

[15] "Share with other professionals how I engage the public in Earth and space science" (p=0.014, r=0.024).

meeting upon arriving home. When reflecting on the impact of the Partner Meeting, a few of the interviewees said they had future plans related to something they learned at the conference. These ideas included adding new resources to their offerings, incorporating some of the content they learned into planetarium shows, and implementing teacher check-out kits, which was something they heard others were doing. The interview data also indicated that meeting attendees felt the Partner Meeting was valuable because they received knowledge of new work that was occurring in Earth & space fields and left inspired and energized.

5. Findings: What kinds of partnerships are formed between professionals during SEISE?

5.1 Background information on the SEISE project's partnership resources

The SEISE project offered many opportunities for professionals to learn about how collaborating with various individuals and organizations could support Earth and space related activities. In particular, SEISE encouraged partnerships with different subject matter experts (SMEs) including local scientists, Solar System Ambassadors, local student volunteers, retired professionals, and people involved in astronomy clubs. SEISE also offered resources and ideas for working with community partner organizations such as schools, community centers, libraries, afterschool programs, and scout troops.

Information related to partnering was disseminated through various online workshop sessions. The following list provides a sense of the types of collaborations that were highlighted through the workshops, a full list of the online workshops offered during the SEISE project can be found in Appendix A: Online Workshops.[16]

- Finding and collaborating with astronomy experts and volunteers
- Girl Scouts and STEM: New space science badges and opportunities to connect with the *Explore Science: Earth & Space Toolkits*
- Museum community partnerships – Part 3: Afterschool programs: Advocating, collaborating and bringing Earth and space content to out-of-school time
- Museum school outreach and field trips in the time of COVID uncertainty

The 2019 Partner Meeting in Tempe, AZ also had many sessions devoted to sharing ideas for partnerships. During panel sessions, SEISE partners described their own experiences and suggestions related to a range of collaborations, such as the following:

- Partnerships with youth-serving organizations (afterschool programs, scouts, Y's, 4-H, and more)
- Working with teachers and schools to engage K-12 students in informal learning environments
- How to prepare and train event volunteers and staff
- Collaborating with experts: How to find and collaborate with subject matter experts
- Partnerships with community organizations and libraries
- Partnerships in unusual places (places of workshop, prisons, the beach, and canoes): Best practices, strategies, and resources for local partnerships

Besides these online and in-person opportunities, the SEISE project created and shared various resources that professionals could use to develop successful collaborations. For example, each year with the toolkit, SEISE provided a "Planning, partnership, and program guide."[17] SEISE

[16] All of the SEISE project's online workshops are recorded and archived on the NISE Network website, along with online workshops from other NISE Net projects. They can be found through the following link. www.nisenet.org/online-workshop-recordings.

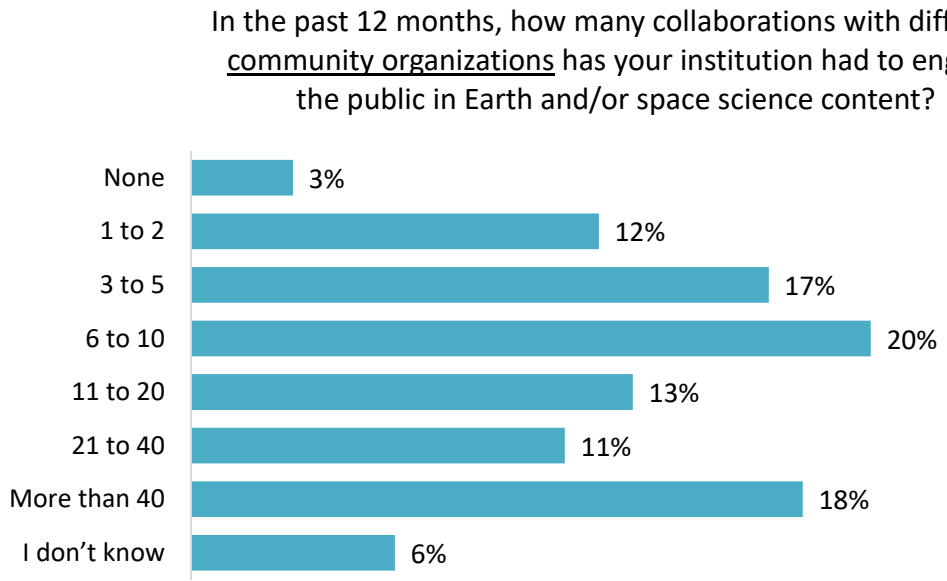
[17] The "Earth & space planning, partnership, and program guide" was included with each toolkit. The guides can be found at the following link: https://www.nisenet.org/catalog/explore-science-earth-space-event-planning-and-promotion-guide

also made use of resources from previous NISE Network projects to support Earth and space efforts including the "Museum & community partnerships: Collaboration guide."[18]

5.2 Almost all professionals were collaborating in a variety of ways with community organizations and subject matter experts.

Collaborations on the survey were defined as either one-time or frequent and could have included working with outside partners who presented content directly to public audiences, staff or volunteers, or groups or individuals who provided a location or audience for an event. Based on the 2019 APS data, it was evident that professionals were overwhelmingly partnering with others when doing Earth and space programming. Overall, 93% of professionals reported collaborating with community, SMEs, or both types of groups for Earth and space content. Specifically, 91% of professionals reported collaborating with community partners and 83% reported partnering with SMEs. For the 91% who collaborated with community organizations, when asked to describe how many of these types of collaborations their institution had in the past year, the numbered varied widely. As can be seen in Figure 4, almost half of the professionals (49%) had between 1 and 10 collaborations, while 13% had between 11 and 20, 11% had between 21 and 40, and 18% reported more than 40 community collaborations to engage the public in Earth and/or space science content.

Figure 4: *Professionals' responses for how many collaborations their institution had with different community organizations. 2019 APS, N=256*

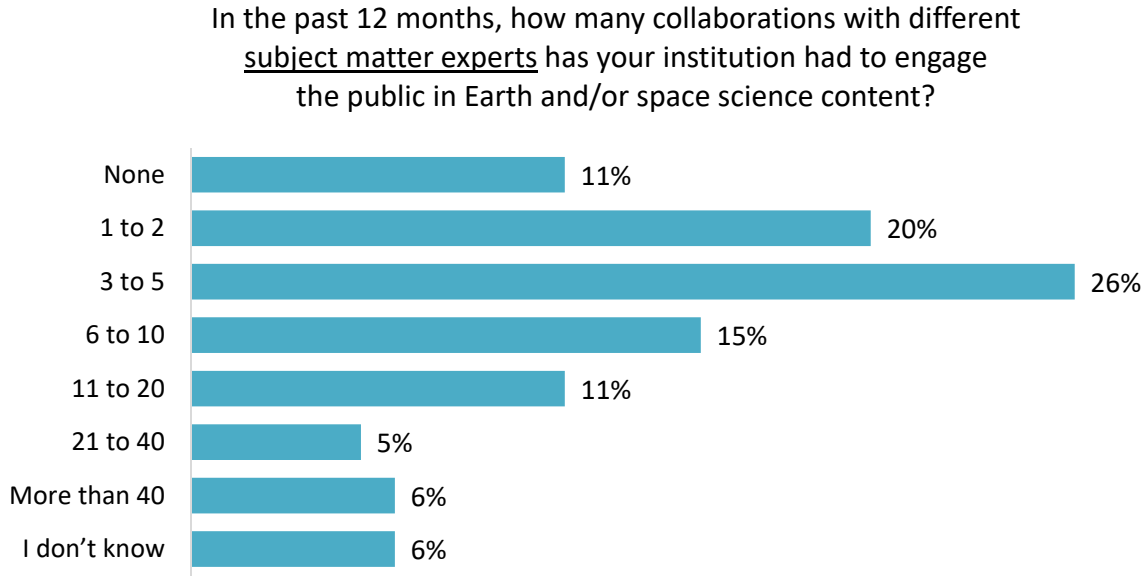


During interviews, almost all of the professionals mentioned a community partnership related to Earth and space science. Specifically, interviewees brought up their work with schools, libraries, and Girl Scouts as examples of the types of community partnerships they had around this topic. Additional community partnerships related to Earth & space included university collaborations connected with community groups, other types of ISE organizations, parks and recreation departments, teachers, Boy Scouts as well as groups specific to their location or setting.

[18] Initially developed for the Nano NISE Network, the SEISE project shared the "Museum & community partnerships: Collaboration guide" with the toolkits: https://www.nisenet.org/collaboration-guide

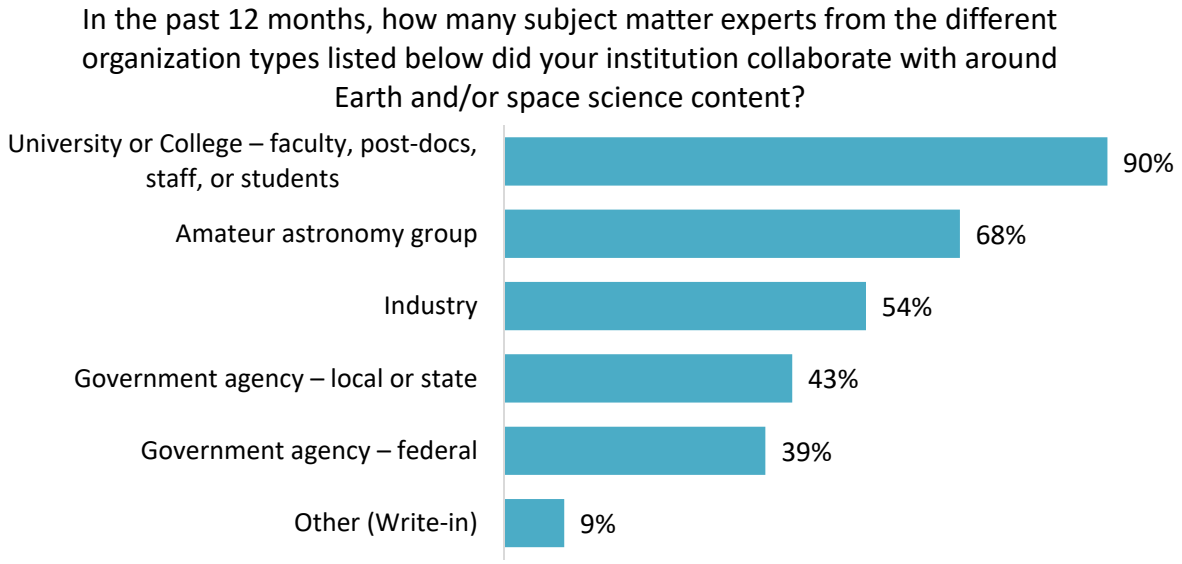
For the 83% of professionals who collaborated with SMEs, they generally reported a smaller range of SME partners. Figure 5 illustrates that almost half of professionals (46%) reported that their institutions collaborated with between 1 and 5 SMEs in the last year. Meanwhile, 15% had worked with between 6 and 10, 11% had partnered with 11 to 20, and 11% worked with 21 or more SMEs in order to share Earth and/or space science content with the public.

Figure 5: *Professionals' responses for how many collaborations their institution had with different subject matter experts. 2019 APS, N=256*



On the 2019 APS, professionals reported that when collaborating with SMEs, they typically worked with academia (90%) and amateur astronomy groups (68%). Some also partnered with industry (54%), local or state government agencies (43%) such as a parks department or the Department of Environmental Protection, or federal government agencies (39%) such as NASA or NOAA. See Figure 6.

Figure 6: *Professionals' responses for which types of organizations the SMEs they worked with belonged to. 2019 APS, n=212*



The survey responses about the specific types of SMEs that professionals were partnering with matched what was heard during interviews. All of the interviewees talked about how they had some sort of partnership with a SME related to Earth and space science. These partnerships ranged in terms of duration, from one-time events to ongoing projects. Typically, interviewees talked about bringing in partners for special programs, lectures, field trips, camps, or science café opportunities. Almost everyone partnered with some sort of university-affiliated scientist, professor, or group/organization such as a university planetarium, museum, fraternity, or specific department or class of students. Many interviewees also described partnerships with NASA-related individuals or facilities, along with NASA-related groups such as Solar System Ambassadors. Several interviewees had partnerships with local amateur associations, such as the Night Sky Network, whose members had volunteered at different events. Other types of SME partnerships that interviewees described included connecting with non-academic scientists, former museum staff with particular Earth and space backgrounds, staff at other organizations, individuals at an observatory, and local industry partners.

5.2.1 Additional insight on NASA partnerships

The 2019 APS data indicated that close to 40% of partners collaborated with federal government agencies or people who represent them, such as NASA SMEs, for their Earth and space efforts, as shown in Figure 6. The interviews provided more insight into what those partnerships may have involved. Overall, this work included partnering with Solar System Ambassadors and inviting astronauts or university affiliated-NASA individuals to take part in various types of events. For example, one individual said that for their Café Scientifique programming, "We've had several, either astronomers or astronomy in Earth and space adjacent, speakers come in, including folks from NASA" (#11). Another interviewee, described how for their Apollo event, they "used a bunch of the materials from the kit and we also brought in a NASA Solar System Ambassador to speak on the history of lunar exploration and what the Apollo missions were all about and also what's the future" (#9). A few individuals also noted partnering with NASA centers such as Ames, Goddard, or Marshall. Moreover, a few of the interviewees worked for an institution that had a connection to NASA or described how they had personal associations or familiarity with NASA resources due to being a Solar System Ambassador or due to having experience on a previous NASA-related project. These individuals talked about how, at times, they drew on these connections to form NASA-related partnerships.

5.3 Professionals shared that SEISE helped enhance their partnerships through activity materials and training resources.

The interviews provided an opportunity to learn about partnerships beyond the quantitative questions asked on the APS. In particular, professionals explained how SEISE had influenced their existing partnerships, especially in terms of providing useful activity materials. When talking about how they used SEISE activities with community partners, the professionals mentioned taking the toolkits to various events occurring at local organizations such as libraries and schools. Professionals also described using SEISE materials when engaging different types of audiences like Girl Scouts. As one individual said,

> The launch of the new Girl Scout space program and their new badges, which we're offering, it was a perfect fit because some of them are perfectly tied in to the badge requirements. So instead of spending the time to create these things ourselves. They're already there. (#6)

A few interviewees noted the quality of the activities and emphasized that the high level of design was appreciated when working with community partners. As one professional stressed,

> Certainly the hands-on activity kits are great. I can use those if I'm bringing in people to help with a project to create new ties. Those things are there and ready to go and people are coming and don't have to come up with things and they've been tested and whatnot. If I go somewhere like to a library event, I can take them with me. (#9)

Similar to how professionals noted that SEISE resources helped their community partnerships, they also pointed to how the project materials were beneficial when collaborating with SMEs. Specifically, most professionals credited SEISE products and materials with supplementing their events and offerings by giving them resources to use. They shared examples of how they had utilized SEISE materials for special programs with SMEs, such as during an Apollo event with local guest speakers or for outreach involving an amateur astronomy group and the community. As one interviewee stated, "I think what it did was enhanced what [partners at our local astronomy association] were already offering here by giving us a wider variety of topics that we can present to our visitors" (#11). Not only did partners explain that the SEISE materials were often integrated into their SME programming, but several mentioned that thanks to SEISE materials they had increased their number of SME partnerships. Interviewees felt that having the SEISE materials provided opportunities to reach out to SME partners and plan events. The materials also made it easier for partners to commit to these experiences because the materials are so comprehensive. In talking about how the materials had influenced their SME partnerships, one individual described,

> [Partner organizations] appreciate us having this stuff and being able to bring it out, and on my end it makes it easier for me to say yes to these events because it doesn't take a lot of my time to pack, plan, figure out activities, etc. On that level it has definitely increased the amount of events that we're able to be at with good quality activities. (#8)

The interviews also highlighted how professionals felt that SEISE resources were helpful training assets for partners who were less familiar with engaging public audiences. In particular, interviewees talked about how the training resources were useful for introducing partners with how to talk to the public and with increasing their comfort level for presenting. A few interviewees felt that SEISE materials had allowed their SME volunteers or partners to feel more at ease participating in the events because the toolkits have instructions, lists of frequent questions that might come up, and tips on how to interact with visitors. These components allowed SMEs who may have been less comfortable with informal education or working with younger audiences to use the activities successfully. One interviewee shared a story about how a graduate student "really wanted to participate [but] was kind of hesitant about working with

younger learners, and so we sat him down with one [of] the kits . . . and he had some people who were at his table for like hours" (#5). Another interviewee, speaking more generally about how SEISE materials had been useful for training others, indicated,

> Again the biggest thing is being able to share that resource of how to actually interact with guests and share knowledge . . . being able to share that with our industry partners has just made it much easier for them to feel comfortable and confident being part of the program because it gives them that support and that piece that they can learn from. (#4)

As can be seen, interviewees felt SEISE materials were approachable and supported SME participation in their events. In addition, a couple of interviewees explained that they had shared SEISE resources with their SME partners either as "jumping off points" (#4) or as materials that these partners could learn from or borrow. The fact that interviewees had not only used SEISE materials to train SMEs, but distributed these resources to benefit their partners' work is another example of how the SEISE project has influenced museum partnerships.

6. Findings: How does SEISE impact professionals' knowledge and understanding of Earth and space content areas?

6.1 Background information on the SEISE project's content offerings

As part of the SEISE project, the products, resources, and professional development opportunities that were created focused on the Science Mission Directorate's (SMD) content areas. These materials included content about astrophysics, Earth science, heliophysics, planetary science, and each topic's societal dimensions. The lists below provide an overview of the professional development that SEISE offered for professionals to enhance their knowledge of these four topic areas and to increase their ability to convey this information to their audiences. For this work, the SEISE team was guided by a learning framework and content map that illustrated how these ideas were connected to the exhibition and the toolkits, see Appendix B: Learning and Content Frameworks.

Overall, SEISE offered various online workshops that shared details about the content integrated into the toolkits. In particular, the project ran a series of workshops called "The Science Behind the *Explore Science: Earth and Space* Toolkit" that focused on specific topics or kit activities. The following list provides examples of the types of themes that were covered in this series to increase professionals' understanding of the SMD content areas. A full list of the online workshops offered during the SEISE project can be found in Appendix A: Online Workshops.

- Exploring Earth and the Solar System
- Looking Beyond the Solar System
- Exploring the Universe
- Asteroid Mining
- Using Your Toolkit to Present the Life Cycle of Stars
- Virtual Tour of a NASA Mission Prototyping and Testing Lab
- Astrobiology – Searching for Life
- The Changing Earth

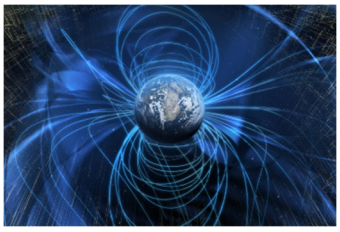
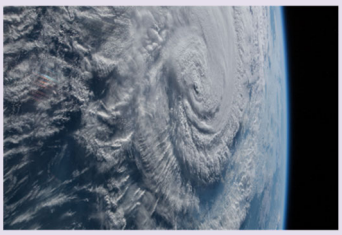
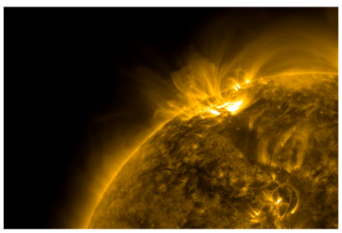
During the 2019 Partner Meeting in Tempe, AZ, partners had opportunities to learn about the content included in the SEISE products, along with some of the latest information from NASA. Plenaries were focused on sharing new and exciting Earth and space research including Lindy Elkins-Tanton's "Space Initiatives at ASU," Jim Bell's discussion of his book *The Ultimate Interplanetary Travel Guide: A Futuristic Journey Through the Solar System*, and "Big Stories in Earth & Space Science." Some sessions, such as the "Incorporating Earth and space science content into your summer camp," included resources for partners to learn more about the content. The Partner Meeting also included a showcase of NASA Science Activation projects, where representatives from these efforts shared other available materials that could support learning about and presenting Earth and space content.

In addition to the SEISE hands-on activities and exhibition, which had embedded SMD content information, the project offered additional resources that were created to help professionals better facilitate these experiences and be comfortable talking about the SMD topics presented. For each toolkit activity, SEISE created a training video and facilitator guide, reviewing the relevant content for professionals. The *Sun, Earth, Universe* exhibition included a museum educator guide and walkthrough video for staff and volunteers that highlighted relevant content.

6.1.1 Alignment between Science Mission Directorate topics and Annual Partner Survey definitions

For the Annual Partner Survey (APS), the four SMD topics, astrophysics, Earth science, heliophysics, and planetary science, were translated into five content areas, with astrophysics being covered by two categories: "galaxies and beyond" and "forces and energy of the universe." Table 5 displays how the SMD content areas and the APS categories relate to each other. Beyond the SMD topics, the survey also asked about an additional cross-cutting area: "connections between Earth and space research and our society," a specific emphasis of the Network. Overall, professionals were asked a series of questions about all of these areas including their confidence in facilitating these topics, how SEISE had impacted their confidence, and how often they covered these areas at their institution.

Table 5: *Science Mission Directorate content area definitions and connections to Annual Partner Survey categories*

SMD content areas	APS content areas and definitions	
Astrophysics	**Galaxies and beyond** (e.g. stars, birth of the universe, black holes, sizes and distances in space)	
	Forces and energy of the universe (e.g. gravity, electromagnetic spectrum, magnetism)	
Earth science	**The changing Earth** (e.g. climate change, plants and animals, ocean, atmosphere, geology)	
Heliophysics	**Living with the sun** (e.g. energy from the sun, eclipses, shadows, solar flares	

Planetary science	**Our solar system and planets around other stars** (e.g. orbits, icy moons, the search for life, exoplanets)	
NISE Network focus	**Connections between Earth and space research and our society** (e.g. our values influence Earth and space science questions, Earth and space research can inspire us and result in new technologies, studying Earth and space helps us make better decisions about our home in the universe, we address challenges in Earth and space.)	

6.2 Professionals' confidence in facilitating the SMD content areas significantly increased with their involvement in SEISE, and most reported using SEISE materials for presenting all content areas. SEISE had the most impact on professionals' knowledge and use of content related to "our solar system and planets around other stars."

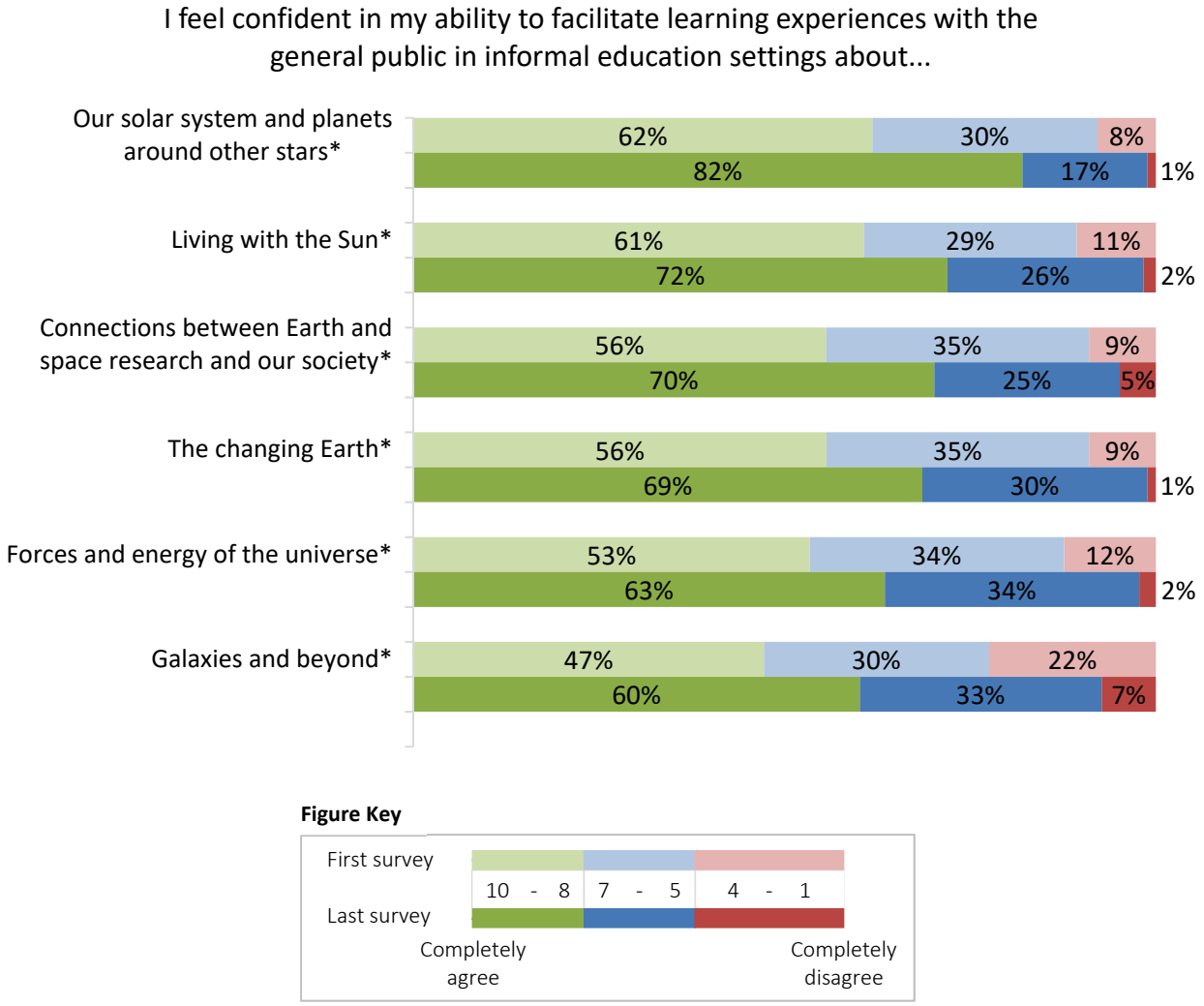
6.2.1 Professionals' confidence in facilitating Earth and space topics

When asked on the APS about their confidence facilitating SMD-related topics with public audiences, professionals indicated high levels of confidence at the end of the SEISE project. Not only did professionals rate their confidence very high on their last survey, with 60% or more saying they were confident in facilitating these topics, but analysis of the longitudinal sample showed statistically significant growth for all areas.[19] In particular, SEISE had the most impact on partners' confidence in the area of "our solar system and planets around other stars," as suggested by this topic having the largest effect size across the SMD-related areas.[20] More broadly, 82% of professionals reported on their last survey that they felt very confident in facilitating this content area, see Figure 7. Other topic areas where professionals indicated high confidence on the final survey were "living with the sun" (72%) and "connections between Earth and space research and our society" (70%). Although fewer people were highly confident on their final survey for the area "galaxies and beyond" (60%), this was the area where the most professionals indicated a change in confidence between their two surveys.

[19] "Our solar system and planets around other stars" (p<0.000, r=0.44); "Living with the Sun" (p<0.000, r=0.33); "The changing Earth" (p<0.000, r=0.32); "Galaxies and beyond" (p<0.000, r=0.37); "Forces and energy of the universe" (p<0.000, r=0.30); "Connections between Earth and space research and our society" (p<0.000, r=0.37).

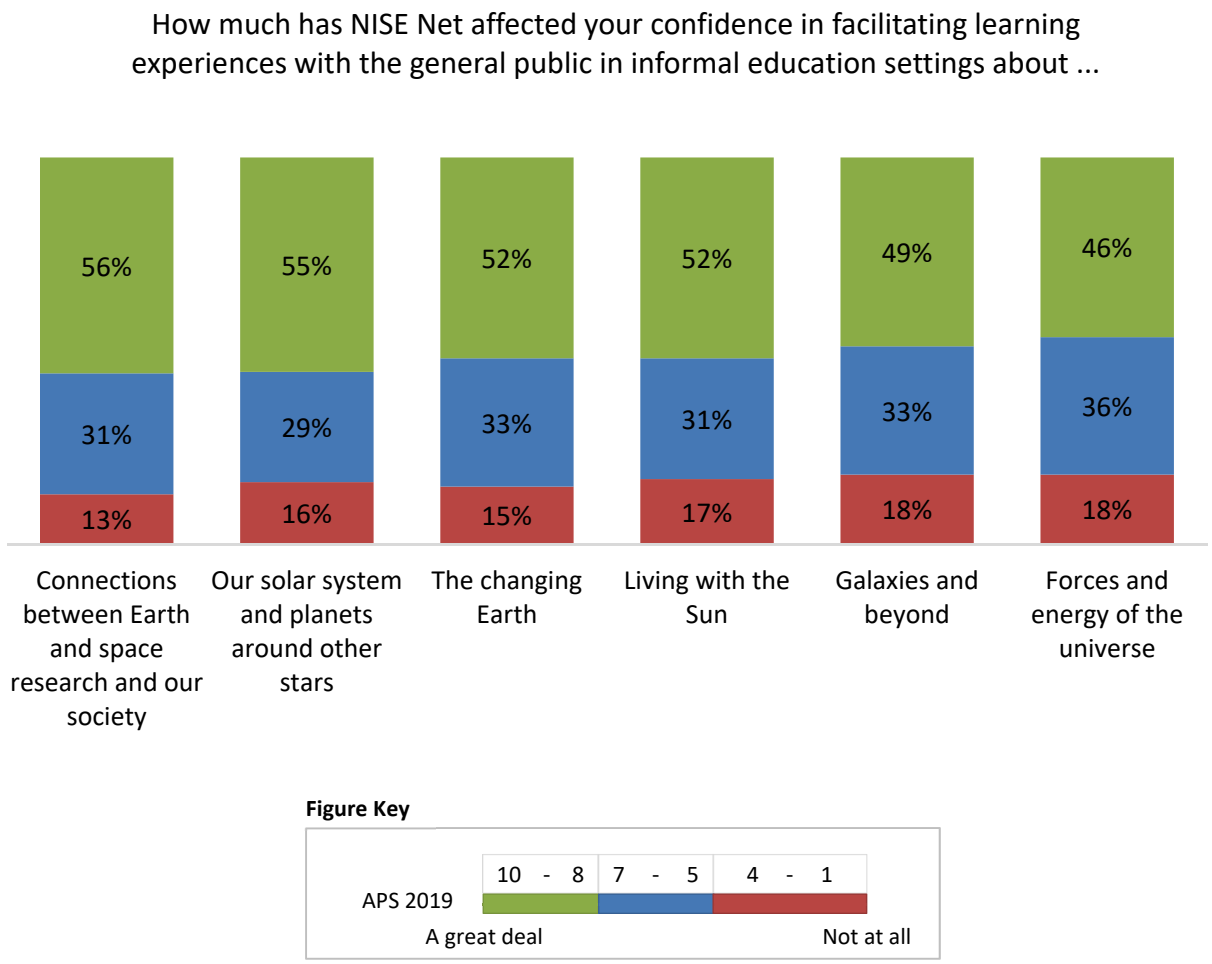
[20] "Our solar system and planets around other stars" (p<0.000, r=0.44)

Figure 7: *Professionals' confidence in their ability to facilitate learning experiences for SMD content areas. Longitudinal analysis, N=178*



On the 2019 APS, professionals generally agreed that the NISE Network helped impact their confidence in facilitating the SMD-related topics, see Figure 8. For all areas, at least 46% of professionals felt that NISE Net had greatly affected their confidence. In particular, professionals reported that SEISE had the most influence on their confidence facilitating "connections between Earth and space research and our society" (56%) and "our solar system and planets around other stars" (55%). SEISE offered a variety of activities and supporting training materials that emphasized societal connections, such as "Exploring the Universe: Pack a Space Telescope" or focused on a particular content area, such as "our solar system and planets around other stars" that is emphasized in "Exploring the Solar System: Ice Orbs." See Appendix C: *Explore Science: Earth & Space* Toolkit Activities for a list of all of the toolkit activities and the content included in each.

Figure 8: *Professionals' responses to how much the NISE Network affected their confidence in facilitating the SMD-related content areas. APS 2019, N=256*



In the interviews, professionals were asked about their experiences related to the SMD content areas to help provide insight into the APS data and how SEISE may have impacted professionals' confidence. Interviewees varied in their levels of SMD content knowledge before becoming involved in the SEISE project. Some interviewees described having limited familiarity of the topics, while others explained they had expert level understanding of Earth and space science. When talking about the SMD content areas, some professionals mentioned how they were more comfortable with Earth topics as compared with space science or vice versa. Regardless of how confident professionals were when they started, including those who came to the project with high levels of confidence and knowledge, most interviewees shared that they had increased confidence in facilitating learning experiences around Earth and space topics due to SEISE.

Through the interviews, professionals generally attributed these feelings to the background information provided with the toolkit activities, along with the online workshops. As one individual shared, "All the materials that come with each different activity, just being able to read through that and have that at my fingertips so I can literally pop one out, read over those materials quickly, and be able to deliver that program very quickly and easily" (12). One of the partners who started with a high level of knowledge said they were more confident after gaining new ways to explain content that had been familiar to them. A few partners noted that beyond learning from the project materials, the activities had increased their interest in discovering

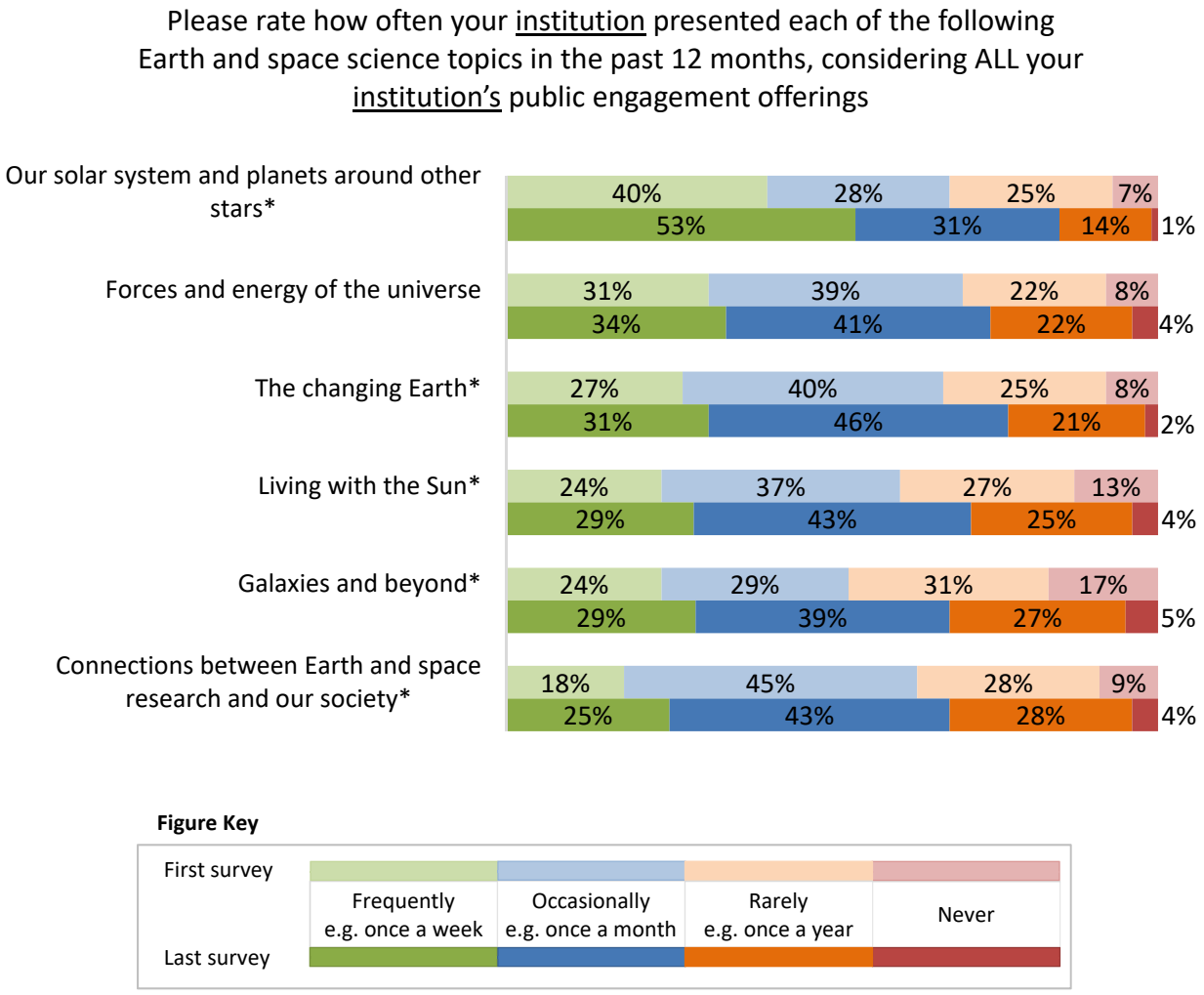
more about Earth and space topics. As a result, they had done research on their own to learn more about the science related to the toolkit activities, likely further supporting their increased confidence in presenting these topics to the public.

6.2.2 Opportunities for facilitating Earth and space topics and using SEISE materials for this content

In addition to increasing their own confidence, professionals shared that their institutions were offering significantly more public engagement opportunities than at the beginning of the project for many of the SMD content areas. [21] On the final survey, the area most often offered was "our solar system and planets around other stars," with over half of professionals (53%) reporting that their institution presented this topic frequently (e.g. once a week). As shown in Figure 9, at the end of the project, the next two most frequently presented topics were "forces and energy of the universe" and "the changing Earth," with 34% and 31% of professionals saying their institution offered weekly opportunities connected with these areas. While all of the content areas were offered by most institutions, "galaxies and beyond" and "connections between Earth and space research and our society" were the least frequently presented, with only 29% and 25% of professionals saying their institutions presented these areas weekly. During the interviews professionals indicated some reasons why a particular topic might not be covered at their institution. For example, a couple of the interviewees shared that "galaxies and beyond," was a topic that their institution would not normally cover or they felt it was too complex or challenging for their target audience age.

[21] "Our solar system and planets around other stars" (p<0.000, r=0.34); "Living with the Sun" (p=0.001, r=0.25); "The changing Earth" (p=0.009, r=0.34); "Galaxies and beyond" (p<0.000, r=0.39); "Connections between Earth and space research and our society" (p<0.008, r=0.21).

Figure 9: *Professionals' reporting how frequently their institutions were offering experiences related to the SMD content areas. Longitudinal analysis, N=170*[22]

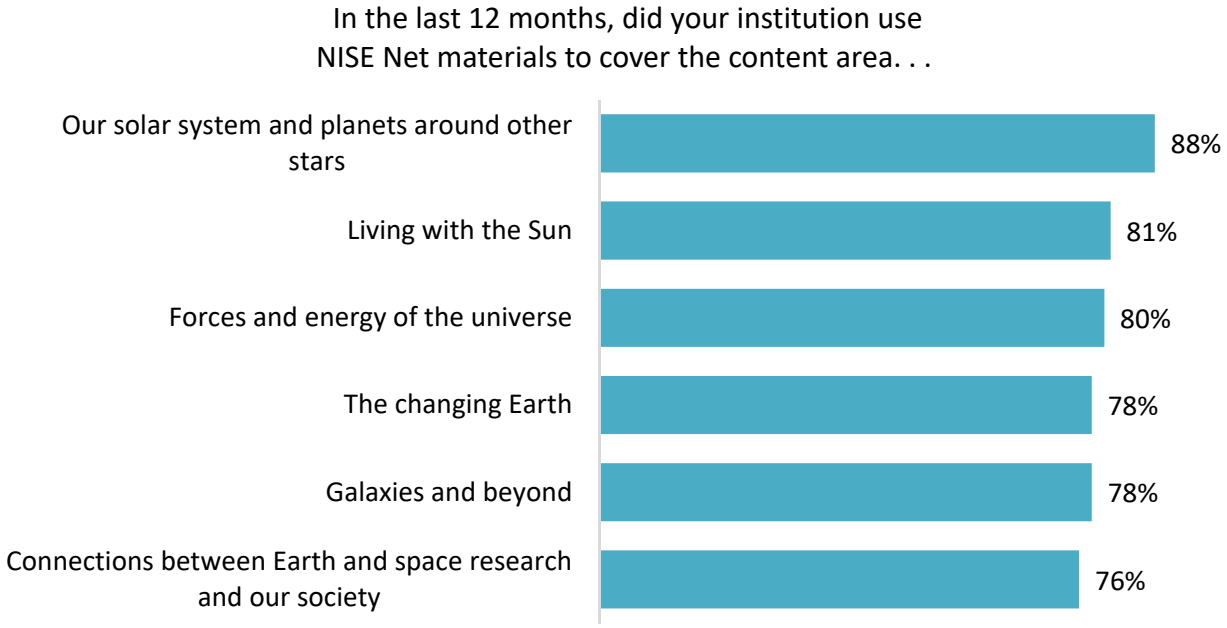


Beyond institutions increasing how frequently they were presenting the six content areas, most professionals indicated they were using SEISE materials to do this work. At the end of the project, over 76% of professionals shared that they used SEISE products to engage audiences in all of the content areas on the survey, see Figure 10. Most professionals reported using SEISE materials to present "our solar system and planets around other stars," "living with the Sun," and "forces and energy of the universe," with at least 80% using project materials for these content areas. Even for the area where the fewest professionals said they used SEISE materials, "connections between Earth and space research in our society," over 75% reported using project resources. It is important to note that the content area that the most professionals said they used SEISE materials for, "our solar system and planets around other stars," was also the area that professionals reported being most confident in (Section 6.2.1) and that their institutions presented most frequently (Figure 9). In the interviews, professionals identified activities from the toolkits that they could use with each of the content areas. In particular, many partners had examples for activities connected to "our solar system and planets around other stars," such as

[22] "Living with the sun" n=167; "The changing Earth" n=166; "Our solar system and planets around other stars" n=169; "Connections between Earth and space research and our society" n=155.

"Exploring the Solar System: Pocket Solar System" and "Exploring the Solar System: Magnetic Fields."

Figure 10: *Professionals who indicated that their institutions were using SEISE materials to cover SMD content areas. 2019 APS, n=232*[23]



6.3 Professionals reported that their institutions increase how frequently they were offering experiences related to the SEISE learning framework, and that SEISE supported these efforts

Beyond integrating SMD content, toolkit activities were designed to allow participants to experience phenomena, use the scientific and engineering process, or participate in the scientific community.[24] These three types of experiences were outlined in the learning framework for the SEISE project and helped guide activity development. For more details see Appendix B: Learning and Content Frameworks and Appendix C: *Explore Science: Earth & Space* Toolkit

[23] "Connections between Earth and space research and our society" n=234; "The changing Earth" n=238; "Forces and energy of the universe" n=239; "Our solar system and planets around other stars" n=243

[24] **Experiencing phenomena** (e.g., use a gravity well, detect different wavelengths of light with a special camera, examine magnetic field models of a planet)

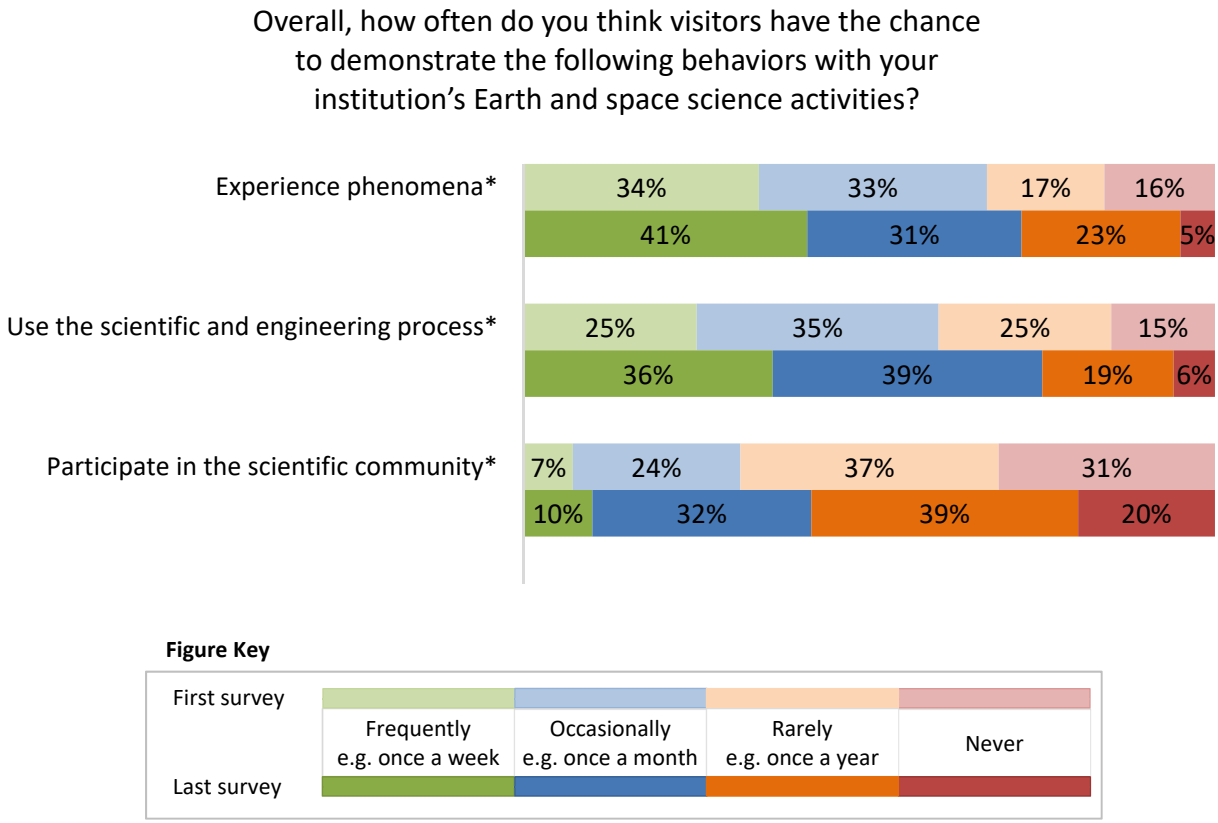
Using the scientific and engineering process (e.g., collect data from a light meter to graph the orbit of a model exoplanet around a star, use maps of global temperature over time to generate questions about climate change, try multiple designs of a rocket to hit a target in a launching experience)

Participating in the scientific community (e.g., participate in training for a citizen science program to identify and count moon craters, take measurements of local weather conditions with a class and report them on a community website, work with groups of visitors to discuss how space science could impact their future)

Activities. Overall, most activities in the toolkit allowed visitors to engage in two or three aspects of these different learning experiences.

As these three experiences were important to the design of the toolkit activities, the APS included questions around these three areas. Data from the longitudinal sample indicated that professionals offered significantly more opportunities for visitors to engage in each of the three learning behaviors after participating in SEISE, see Figure 11.[25] In particular, on the final survey, many professionals indicated that their institutions frequently (e.g. once a week) offered visitors opportunities to "experience phenomena" (41%) or "use the scientific and engineering process" (36%). Although professionals shared that visitors had the fewest opportunities to "participate in the scientific method" (10% said "frequently") when engaging in Earth and space activities at their institution, statistically significant increases were seen for how often visitors had the opportunity to do so over the course of the SEISE project. Additionally, more professionals reported that their institution offered opportunities to participate in the scientific community at least occasionally, rather than never, after involvement with the SEISE project.

Figure 11. *Professionals' ratings of how often visitors had opportunities to practice the learning framework behaviors. Longitudinal analysis, n=152*[26]



Additionally, the 2019 APS data indicated that many professionals were using SEISE materials to engage the public in the learning framework behaviors. Most professionals used SEISE materials to engage the public in "using the scientific and engineering process" (89%) and

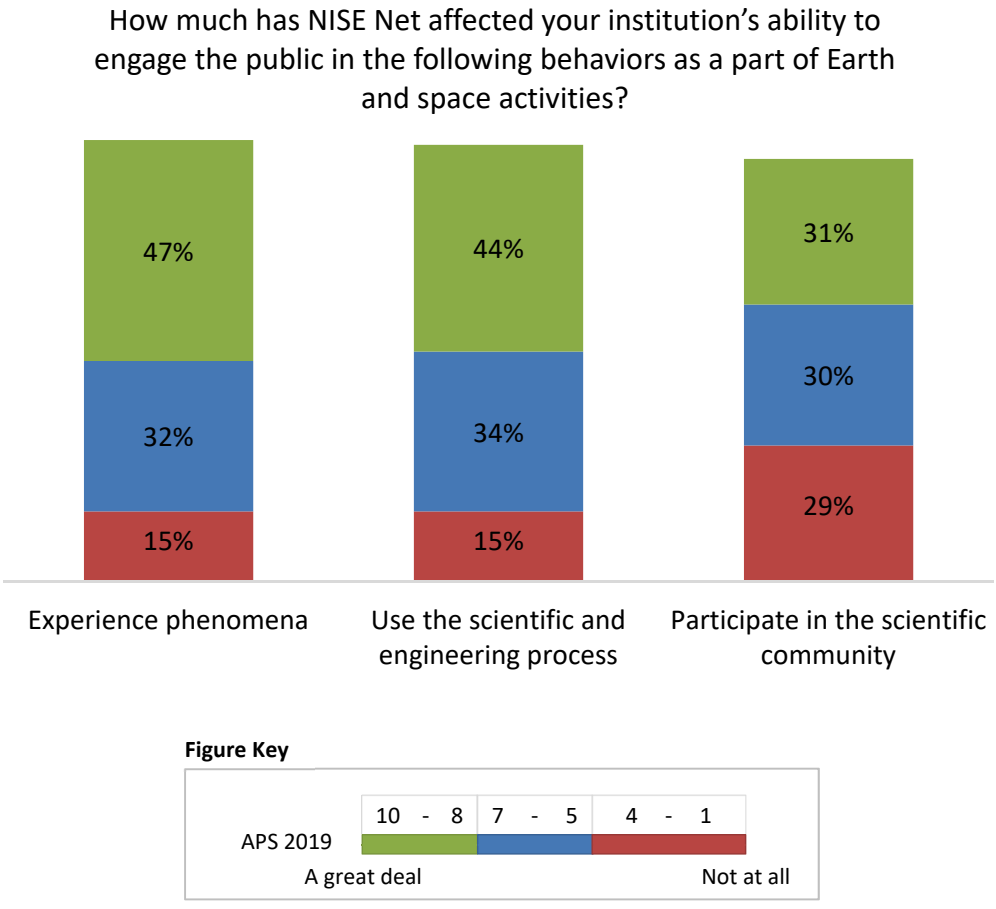
[25] "Experience phenomena" (p=0.008, r=0.21); "Use the scientific and engineering process" (p<0.000, r=0.32); "Participate in the scientific community" (p<0.003, r=0.24)

[26] "Experience phenomena" n=152; "Use the scientific and engineering process" n=150; "Participate in the scientific community" n=148

"experiencing phenomena" (86%). Fewer professionals used SEISE materials for "participating in the scientific community" (64%). However, as shown in Figure 11, this was the learning behavior that institutions were least likely to offer to their visitors.

Professionals varied in their agreement for how much the SEISE project helped them engage the public in the learning framework behaviors, as shown in Figure 12. The SEISE project had the most impact on institutions' abilities to have visitors "experience phenomena" and "use the scientific and engineering process," with 47% and 44% of professionals rating the impact highly. Although fewer professional rated the influence of SEISE as high for "participating in the scientific community" (31%), nearly a third of professionals felt that SEISE helped them accomplish this goal. As shared above, "participating in the scientific community" was also the area where the fewest professionals felt visitors had the opportunity to demonstrate this behavior or reported that they used SEISE materials when they did this type of work, so professionals may not recognize all of the ways these behaviors were possible in the SEISE materials.

Figure 12: *Professionals' ratings of how much the NISE Network had affected their institution's ability to engage the public in the learning framework behaviors. 2019 APS, N=256*



The interviews provided insight into how professionals were using SEISE materials to engage visitors in behaviors related to the learning framework and whether they recognized that the materials could be used in these ways. In general, professionals had narrower definitions for the areas than the Network does. However, interviewees recognized some of the ways that the SEISE toolkits, and hands-on activities in general, could provide opportunities to engage the

public in the three learning framework behaviors. For example, "Exploring the Universe: Orbiting Objects" was one of a few activities mentioned by interviewees as useful for allowing them to engage the public in "experiencing phenomena." When explaining how the SEISE materials helped them have visitors "use the scientific and engineering process," one interviewee stated that "the hide-and-seek moon activity is a great activity to talk about different technologies that researchers use and the scientists use" (#9). In terms of how they might utilize SEISE materials to encourage "participation in the scientific community," professionals mentioned that events with guest scientists that employed the toolkit activities were a "fantastic jumping-off point for people to get excited and start kind of thinking about the questions and thinking more deeply about questions that they might have" (#5). These examples show how interviewees felt SEISE materials could help them offer opportunities for visitors in the learning framework behaviors.

7. Findings: How does SEISE impact professionals' use of the project's public-facing products and their implementation of practices for engaging the public?

7.1 Background information on the SEISE project's public engagement resources and encouraged practices

The main products created through the SEISE project included four *Explore Science: Earth & Space* toolkits of hands-on activities and the *Sun, Earth, Universe* exhibition. These public facing products were used by professionals to engage audiences in the SMD-related content areas. They also were designed to support professionals in applying broader informal STEM practices encouraged by the Network to their Earth and space efforts. Additional SEISE professional development opportunities around these practices, such as online workshops, offered tips and suggestions on how to utilize them. SEISE also shared a variety of non-NISE Network resources with professionals, such as those created by NASA and other Science Activation partners, in order to enhance their Earth and space efforts.

7.1.1 Overview of the SEISE project's public facing products

The toolkits, available to museums for free and as digital downloads, ultimately contained 45 activities covering NASA's four SMD content areas of astrophysics, Earth science, heliophysics, planetary science, and each of their social dimensions. The activities were designed for families with children ages four and up. Several especially popular activities including "Exploring the Solar System: Pocket Solar System," "Exploring Earth: Bear's Shadow," and "Exploring the Solar System: Stomp Rockets" were distributed in multiple toolkits.[27] In addition to the hands-on activities, facilitator guides, and training videos, the toolkits included information about planning and promoting the required event associated with receiving a kit. All of the public facing materials were available in English and Spanish. Finally, the toolkits also included resources for collaborating with SMEs or volunteers and suggestions for activity extensions.

The *Sun, Earth, Universe* exhibition complemented the *Explore Science: Earth & Space* toolkits by including interactive activities for families with children ages 6-12. In total, 52 copies of the 500-600 square foot exhibition were sent to Network partner museums across the United States. The modular exhibition includes interactives where visitors are able to design, build, and test their own spacecraft model, try out the different types of tools that scientists use to "detect the invisible" (e.g. infrared camera, ultraviolet light, etc.), and explore questions about the Earth, Sun, solar system, and universe. Like the toolkits, the exhibition is bilingual in English and Spanish. More information about the exhibition, the toolkits, and the impacts they had on audiences can be found on the NISE Network's website.[28]

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[27] There were 45 total activities between the four *Explore Science: Earth and Space* toolkits, with 35 unique activities.

[28] *Explore Science: Earth & Space* toolkits: https://www.nisenet.org/earthspacekit.
Explore Science: Earth & Space activity toolkits summative study: https://www.nisenet.org/catalog/explore-science-earth-space-activity-toolkits-summative-study-2019.
Sun, Earth, Universe exhibition: https://www.nisenet.org/sunearthuniverse.
Summative evaluation of the *Sun, Earth, Universe* exhibition (2020): https://www.nisenet.org/catalog/summative-evaluation-sun-earth-universe-exhibition-2020.

7.1.2 Overview of practices encouraged by the SEISE project

In terms of informal STEM practices for Earth and space content, the SEISE project offered opportunities for professionals to learn successful ways to engage a variety of audiences, partner with others, and talk with the public about societal content and difficult concepts related to these topics. SEISE also shared resources for using and adapting non-NISE Network products to enhance partners' Earth and space efforts. The list of online workshops below provides a sample of SEISE's online professional development offerings focused on supporting professionals' practice. Examples of workshops that highlighted the topic of partnering with others and using SEISE materials are listed in Section 5.1, and a full list of the online workshops offered during the SEISE project can be found in Appendix A: Online Workshops.

- Earth & Space Science for Early Learners
- Extending Your Earth & Space Science Exhibits – Free Multimedia Resources from NASA's Universe of Learning, NASA's Eyes, and the NISE Network
- Stories & STEM: Explore the Power of Narrative to Engage Audiences and Enliven Hands-on Science Programs
- Working through Difficult Concepts in the *Explore Science: Earth and Space Toolkit*

During the 2019 Partner Meeting in Tempe, AZ, partners had opportunities to learn about practices that related to the Network's resources. A showcase allowed professionals to hear about the other NASA Science Activation projects and how their products could be useful for engaging audiences in Earth and space as well. Partners were also able to share their own experiences about how to connect with the public and collaborate with others through sessions and informal conversations. The list below includes some titles for the concurrent sessions that covered these topics, with additional sessions listed in Section 5.1.

- Programming for audiences with special needs
- Effective facilitation techniques and strategies to have conversations with your audiences
- Programs and resources to engage teens and adults
- Engaging families and young children in Earth and space science content
- Resources and strategies for engaging girls
- Resources and strategies for engaging bilingual audiences

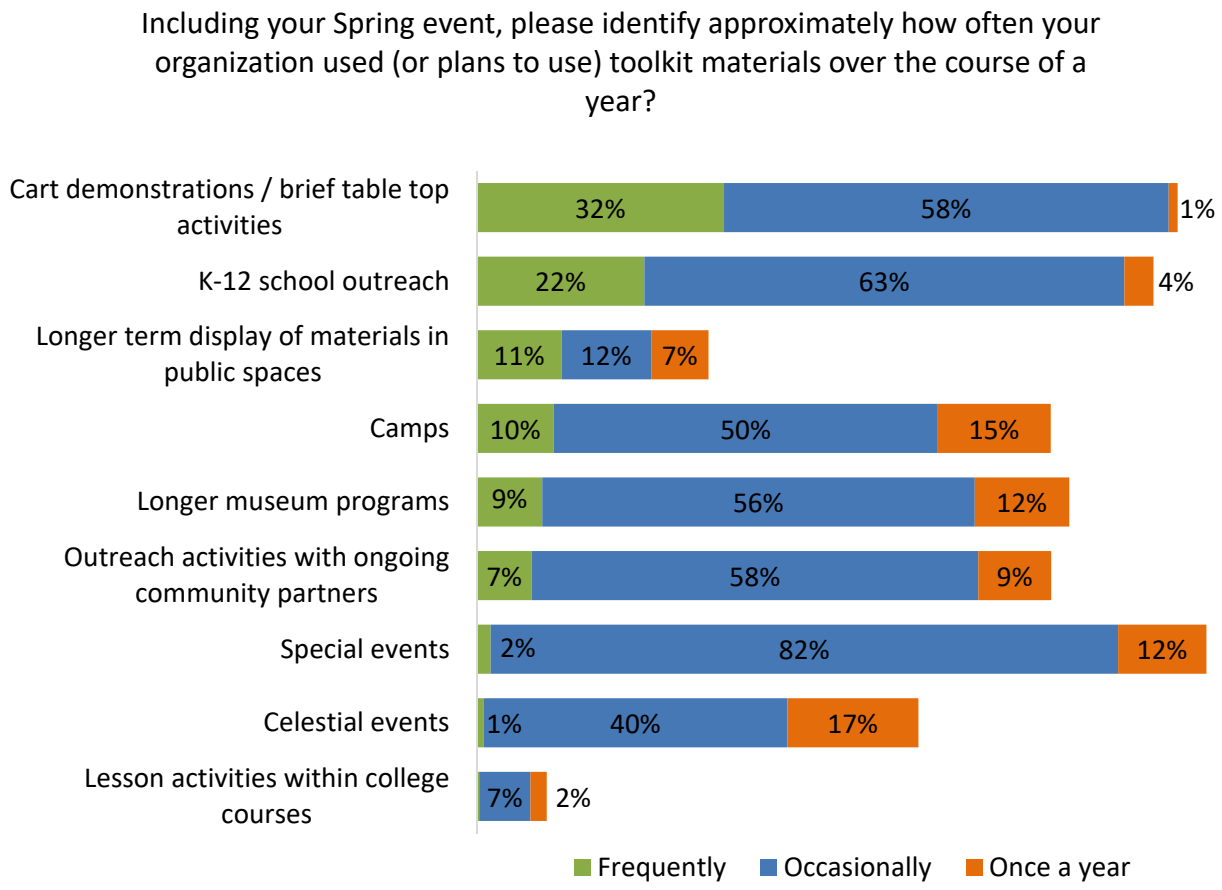
Besides these online and in-personal professional development opportunities, SEISE created many resources, including reference documents and videos, to enhance professionals' informal science education practice. Each toolkit included overarching orientation and training slides, and the activities were accompanied by facilitation guides and training videos. The following list includes some of the specific resources shared with SEISE partners to support their Earth and space science engagement.

- Event planning, partnership, and promotion guide
- *Explore Science: Earth & Space* Strategies for addressing common misconceptions videos
- Tips for leading hands-on activities
- Tips for interaction with young learners
- Tips for accessibility, inclusion, and engagement in museums and planetariums
- Edu-Cathalon: A facilitation strategies and best practices training video for engaging museum visitors in STEM related content
- Strategies for engaging bilingual audiences

7.2 All partner institutions used their toolkit beyond the required event. Toolkits were most frequently used for brief table top activities and K-12 school outreach.

The SEISE toolkits were primarily designed to be used for special events and as brief table-top activities, but they also could be used for a variety of other experiences and formats. As part of the agreement for receiving a kit, partner institutions were required to use the materials for at least one event each year. However, most exceeded this requirement, with 84% of institutions reporting that they used their kits for events much more often, either frequently (i.e. daily, several times a week, or once a week) or occasionally (i.e. once a month or several times a year), see Figure 13. In particular, on the Toolkit Reports, institutions consistently shared that for several different types of formats, including brief table top activities and K-12 school outreach, they were using the toolkits frequently (Kollmann et al., 2018; Kollmann et al., 2019). On the 2019 Toolkit Reports, professionals indicated that kit materials were used most often for cart demonstrations or brief table-top activities (32%) or with K-12 school outreach (22%).

Figure 13. *Institutions' rating for how frequently they used the SEISE toolkit materials each year. 2019 Toolkit Report, N=350*[29]



During the interviews, professionals elaborated on the many ways they utilized the kits, which reflected the most frequently indicated formats from the Toolkit Report. In addition to the required annual event, interviewees talked about using the SEISE materials for other Earth or

[29] "Frequently" includes daily, several times a week, and once a week; "Occasionally" includes once a month or several times a year.

space themed events throughout the year. As one professional shared, "we use [kit activities] for special events, such as our First Friday . . . whenever there's a fit with the theme" (#6). Professionals also described how they used the toolkit activities for everyday use at their institutions, as well as more targeted programs with camps, community partners, or K-12 outreach. One professional explained how their use of the kits expanded the outreach they do with local schools, saying "we started because of all these kits, we started getting younger and younger field trips and the schools are now turning to us to assist them with STEM, well especially in the elementary STEM education" (#2). Interviewees noted that the kits were useful for these different formats because activities are ready to use and include training. As one professional said,

> The kit helps me with training. We have a very young staff, a very inexperienced staff and I always know that with the kits I'm going to have the right information and the training videos that will help make sure my staff knows that's what they're supposed to be doing (#1).

7.2.1 Information about events related to the 2017 solar eclipse and the 2019 Apollo 50th anniversary

In addition to the regular use of the SEISE materials, two notable Earth and space related occurrences happened during the course of the project: the 2017 solar eclipse and the 2019 50th celebration of the Apollo landing. The Network provided resources for programming related to these events, such as themed activities, event planning guides, and additional materials, to encourage the use of SEISE products. A few additional questions were added to the 2017 and 2019 APS to understand how professionals might have used their kits for each of these experiences. For both events, data show that professionals offered educational programming and used SEISE materials.

In terms of the solar eclipse, almost all professionals (96%) reported that their institution offered educational programming related to the 2017 event. Most professionals also reported using SEISE materials for planning (80%) or during the related programming or eclipse event (88%) (Kollmann et al., 2018). Through the interviews, professionals shared details about how they had used the toolkit for programming both leading up to the eclipse as well as during the event. As one interviewee described,

> A lot of the activities that we did at our mini events throughout the summer were pulled from explore science, or explore space, and then at the actual big rooftop party itself we did have a number of hands-on stations for adults and kids to kind of explore and interact with as they were waiting (#5).

Most professionals (88%) also said that their institution offered educational programming about the Apollo's 50th anniversary and many used SEISE materials as a part of their events. Overall, 70% of professionals reported that their organizations used SEISE products for planning and 78% indicated they had used them during programming or events (Kollmann et al., 2020). Interviewees provided examples of activities that felt connected especially well to this celebration, such as "Exploring the Solar System: Craters" and "Exploring the Solar System: Mars Rovers." As one individual explained, these activities allowed visitors

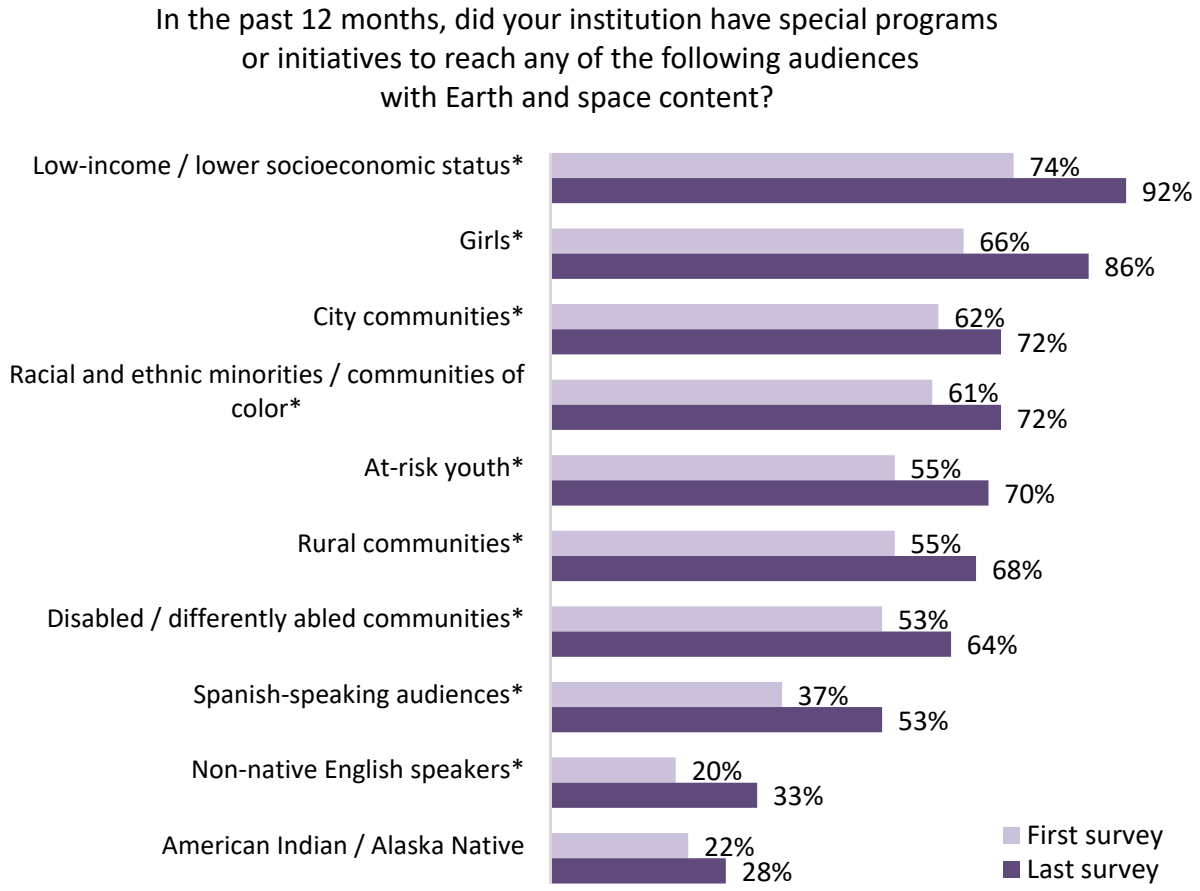
> To actually understand, you know, why does the moon have craters, why is that something we would have to think about. And then how did we actually communicate and not just with the rover but communication in general (#4).

7.3 Professionals reported doing programming with a variety of audiences and significantly increased their programming for diverse or underserved groups over the course of the SEISE project.

The SEISE materials were created for audiences of all ages, produced in English and Spanish, and incorporated universal design principles. Data indicate that over the course of the project, professionals statistically increased the number of Earth and space special programs or initiatives they offered for a variety of audiences.[30] Figure 14 shows that at the time of their last survey, most professionals said their institution had offered Earth and space programming for low-income or lower socioeconomic status groups (92%) or for girls (86%). They not only held programs for these audiences, they also said they used SEISE products to do so. On the 2019 APS, when asked if their institution used SEISE materials in the last year to engage these audiences in Earth and space content, most professionals said this was the case, with at least 76% saying they had done so for each type of audience.

[30] Low-income / lower socioeconomic status, Girls, Spanish-speaking audiences ($p<0.000$); City communities ($p=0.012$); Racial and ethnic minorities / communities of color ($p=0.024$); At-risk youth ($p=0.001$); Rural communities ($p=0.005$); Disabled / differently abled communities ($p=0.029$); Non-native English speakers ($p=0.004$)

Figure 14: *Professionals' responses to whether they had initiatives with specific audiences. Longitudinal sample, n=156*[31]



In the interviews, professionals shared that reaching and engaging diverse and underserved audiences was important to their institution, with a few mentioning that it was specifically part of their organization's mission. Although already a priority at many institutions, the SEISE materials helped professionals provide Earth and space related experiences to diverse and underserved audiences. As one professional shared, "underserved audiences [are] something we definitely bring to the table and . . . you guys have helped us serve them" (#2). Professionals also praised the kits for being easy to use, accessible, and bilingual, as well as offering diverse representation.

7.4 The SEISE project has significantly increased partners' confidence in their ability to address societal content, discuss common misconceptions, and use non-NISE Network materials for Earth and space.

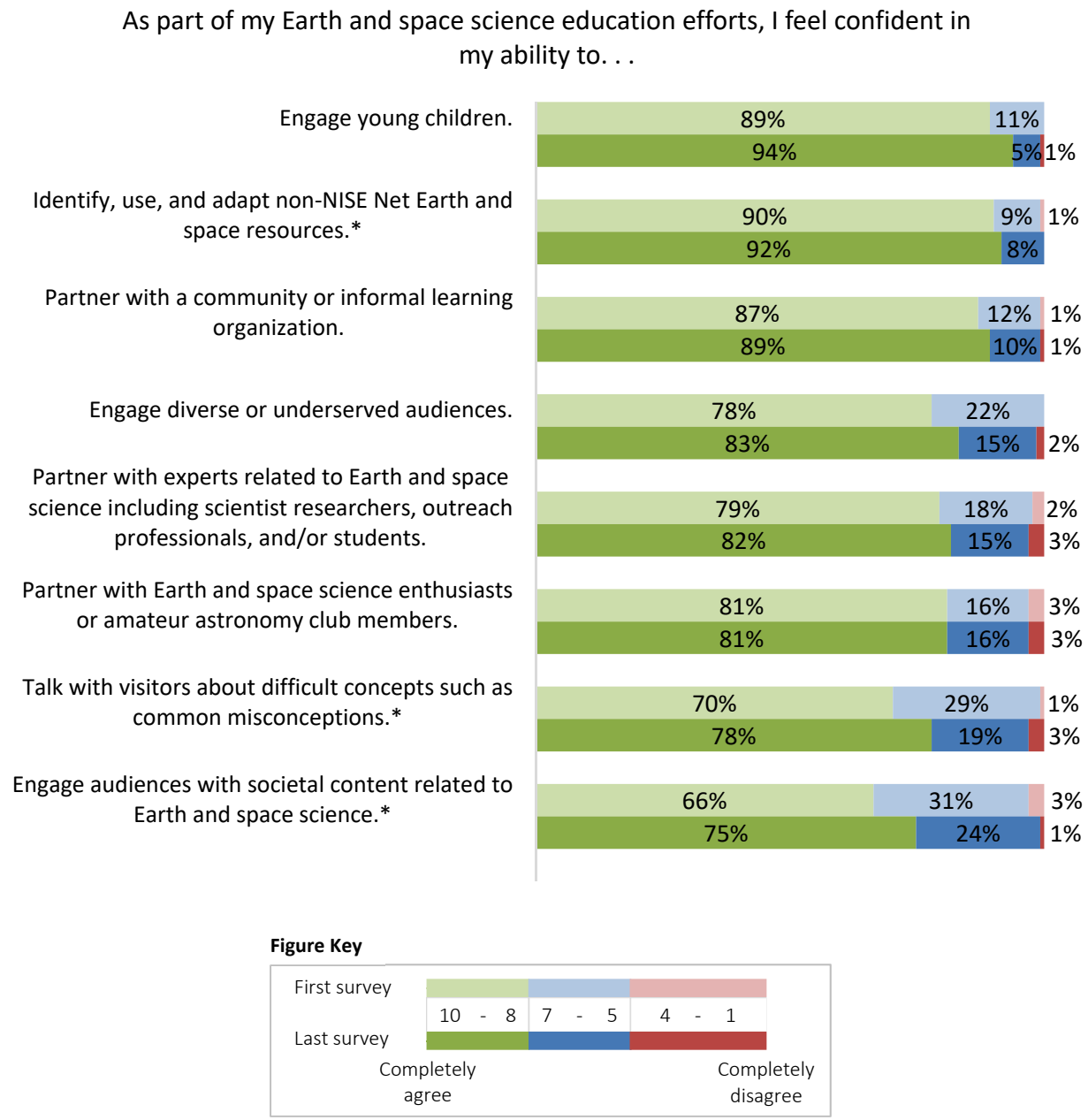
Professionals were asked to rate how confident they were in their ability to do various informal STEM education practices related to Earth and space science. These practices included engaging

[31] Low-income / lower socioeconomic status (n=156); Girls (n=155); City communities (n=148); Racial and ethnic minorities / communities of color (n=147); At-risk youth (n=132); Rural communities (n=143); Disabled / differently abled communities (n=135); Spanish-speaking audiences (n=136); Non-native English speakers (n=127)

specific audiences, such as young children or diverse or underserved audiences, as well as talking with visitors about difficult concepts or societal content related to Earth and space science. Other practices that professionals were asked to rate included how confident they were partnering with different community organizations or SMEs, and identifying, using, and adapting non-NISE Network Earth and space resources. As can be seen in Figure 15, professionals' final ratings for their confidence in these practices equaled or were higher than where they had started at the beginning of the project. Specifically, when comparing professionals' initial and final ratings, the data indicate that professionals were significantly more confident in their ability to "identify, use, and adapt non-NISE Network Earth and space resources," "talk with visitors about difficult concepts such as common misconceptions," and "engage audiences with societal content related to Earth and space science."[32] Although no statistically significant change was seen for the other practices, on the final survey, most professionals expressed confidence in their abilities in these areas. Professionals indicated being very confident in "engaging young children" (94%), "partnering with a community or informal learning organization" (89%), or "engaging diverse or underserved audiences" (83%). For all eight practices, on their final survey at least 75% of professionals rated themselves as having high confidence in these areas.

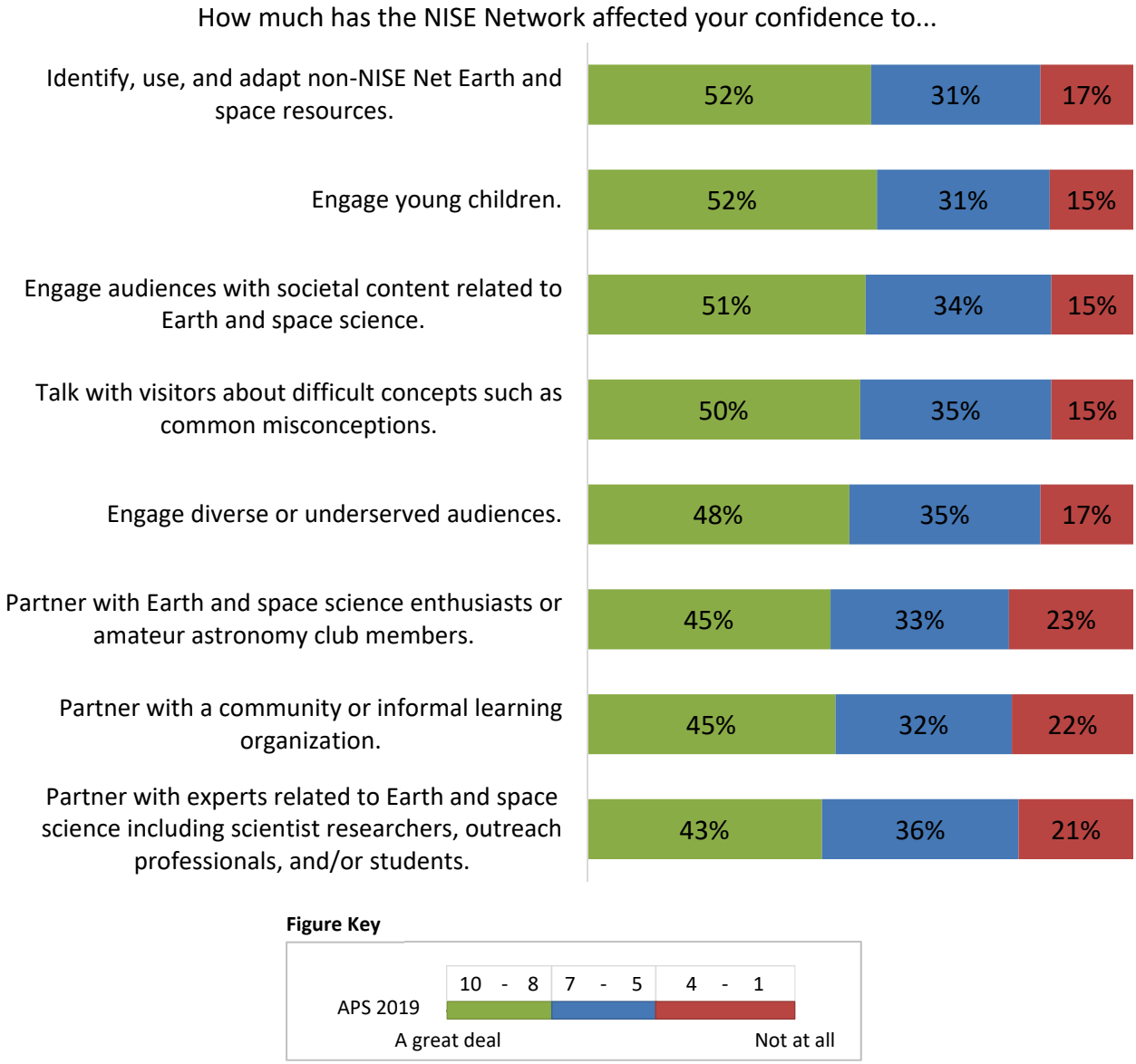
[32] "Identify, use, and adapt non-NISE Net Earth and space resources" (p=0.039, r=0.18); "Talk with visitors about difficult concepts such as common misconceptions" (p=0.044, r=0.18); "Engage audiences with societal content related to Earth and space science" (p=0.003, r=0.26);

Figure 15. *Professionals' confidence ratings in their ability to engage in various informal STEM practices. Longitudinal sample, n=131*



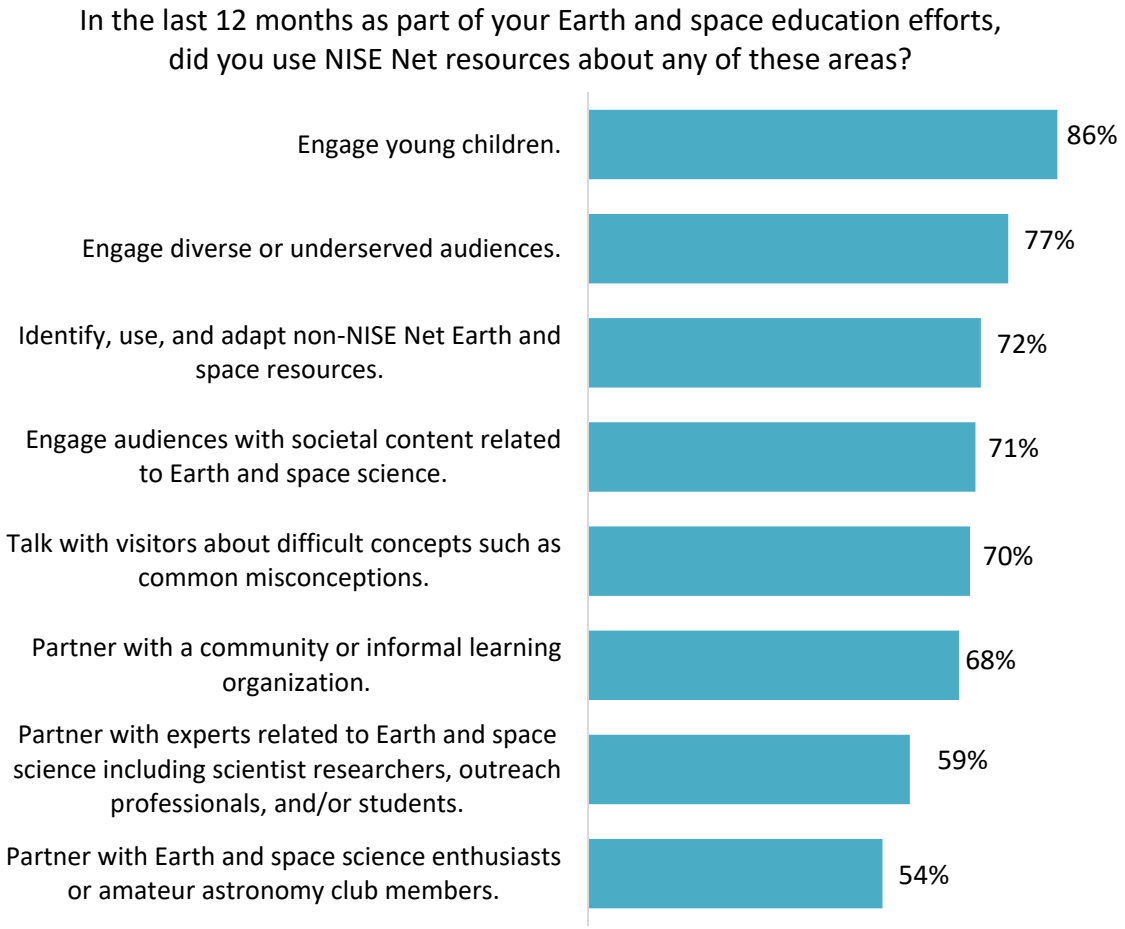
Besides professionals indicating that they were more confident in informal STEM practices after being involved in SEISE, findings from the 2019 APS show that partners often attributed the SEISE project with supporting their confidence in carrying out this work. When asked to rate how much the Network had affected their confidence to do these different practices, at least 50% of professionals felt that SEISE had a great deal of influence in their ability to "engage young children," "adapt and use other resources," "talk to visitors about difficult concepts," and "engage audiences with societal content," see Figure 16. Although fewer professionals felt that SEISE had impacted their confidence in being able to engage diverse or underserved audiences or partner with a variety of individuals and groups, other data from this study point to how SEISE influenced professionals in these areas. See Section 5 and Section 7.3 for other ways the SEISE project supported professionals' practices.

Figure 16. *Professionals' ratings for how much NISE Net affected their confidence in various informal STEM practices. 2019 APS, n=245*



Professionals also indicated that as part of their Earth and space science education efforts they used SEISE resources for all of the different practices asked about on the APS. In particular, 86% of professionals had used SEISE resources when engaging young children, 77% had used SEISE resources when engaging diverse or underserved audiences, and 72% had used SEISE resources to help identify, use, and adapt non-NISE Network Earth and space resources. See Figure 17. Altogether, these survey data point to how SEISE impacted professionals' broader ISE practices in a variety of ways.

Figure 17. *Professionals' responses to whether they used SEISE materials for informal STEM practices. 2019 APS, n=246*



Interviews provided more insight into how SEISE impacted professionals' informal STEM education practices. In particular, interviewees spoke about how the Network had augmented their work around the top four practices in Figure 16, which were all strong focuses of the Network's efforts. As one professional explained, many of these broader practices were already part of their work, but "the toolkit gives us expanded opportunities to engage in some of those practices" (#11). During the interviews, several professionals recounted how they used SEISE resources to train colleagues or volunteers on techniques for engaging young children. Activities such as "Exploring Earth: Bear's Shadow," "Exploring the Solar System: Hide and Seek Moon," and "Exploring the Universe: Imagining Life" were often given as examples of kit activities that worked particularly well with young children and could be used to train staff and volunteers in this practice.

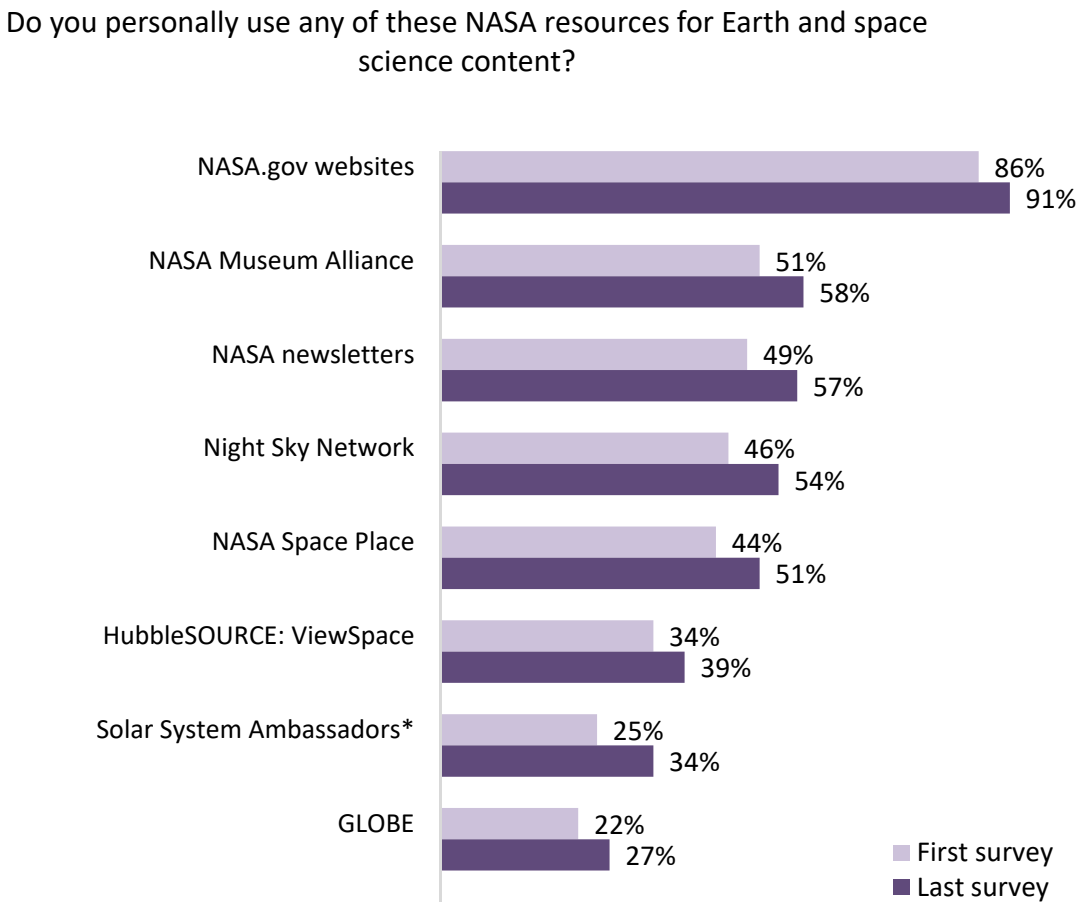
Other interviewees felt that one of the strengths of the SEISE project was that it offered support and resources for talking about difficult concepts and common misconceptions. They shared that SEISE has raised their awareness about various issues to talk about and had provided tools, through kit activities, activity guides, online workshops, and NASA resources, that made them more comfortable talking about misconceptions. Interviewees felt that SEISE's efforts related to difficult concepts had allowed them to expand what they were doing as well. As one professional stated, "I think it just gives us a couple of tools that we can use that are relatable for any age and any background to expand on those concepts without making those individuals feel targeted or excluded from something" (#12). Professionals also noted how the SEISE project helped them integrate societal content, particularly around climate change topics. They used kit activities to support discussions in these areas and mentioned using "Exploring Earth: Land Cover,"

"Exploring Earth: Rising Seas," and "Exploring Earth: Temperature Mapping." Professionals were introduced to many NASA resources that enhanced their ability to identify, use, and adapt non-NISE Network materials for engaging audiences in Earth and space content, which are discussed in Section 7.4.1.

7.4.1 Specifics about professionals' use of NASA resources

Additional information related to partners' use of NASA resources was gathered through surveys and interviews. These data help illuminate how professionals grew in their ability to identify, use, and adapt non-NISE Network Earth and space resources. On the 2019 APS, when asked about usage of NASA resources for their Earth and space science content, almost all partners (91%) reported using NASA websites. While websites were the most frequent NASA resource that SEISE professionals turned to, over 50% also reported using NASA newsletters and the NASA Museum Alliance. Over the course of the SEISE project, statistically significant change was seen in terms of professionals' connecting more with Solar System Ambassadors on their final survey as compared with their first, see Figure 18.[33]

Figure 18. *Professionals' responses to whether they personally use any NASA resources for Earth and space science content. Longitudinal, n=153*[34]



[33] "Solar System Ambassadors" (p=0.031)

[34] NASA newsletters n=162; NASA Museum Alliance n=156; HubbleSOURCE: ViewSpace, GLOBE n=152; Night Sky Network n=155; NASA Space Place n=159;

As part of the interviews, many of the professionals reported learning about NASA resources while participating in the SEISE project. A few mentioned gaining this information from online workshops or the 2019 Partner Meeting's Science Activation Showcase. When describing their increased knowledge of NASA resources, several individuals noted being more aware of the breadth of information available or being more informed about where to look for items from NASA. As one professional stated,

> I was just at ASTC and talking with people about NASA and NOAA. You guys . . . helped sort of funnel things to us that maybe we wouldn't get anyway, and I'm able to understand then what else is happening, so even stuff that's not part of the kits or not on the website, I know where to look and how to find it, and it has been really helpful to sort of have that direct line, I guess. (#2)

Beyond knowledge of the resources, many of the interviewees felt that they had increased their use of NASA resources to some degree due to the Earth & Space project. One individual explained, "It's not something that I would have thought to go to for something other than just like rockets and Mars robots and things. It showed me there's a wider scope of offerings from NASA" (#11). When providing examples of how they have used NASA resources, interviewees spoke about integrating information from JPL and the Mars Exploration Portal for a girls in science event, bringing in available materials for planetarium related programs, and mentioning the latest about "new missions and the real research going on" in units being taught (#6). A couple of individuals talked about how they have shared NASA resources with different groups such as libraries or teachers, while other interviewees talked about how they had adapted a NASA resource. One person who noted drawing from NASA and making some changes said,

> In our space summer camp this year we actually did a whole… I think it was a space station design and we had done designing a colony on an exoplanet before at the activities, but there was one of the NASA sites had a space station design we thought that was really cool so we ended up kind of adapting that program to do that instead. (#5)

One individual felt that the references to NASA in the NISE Net resources related to misconceptions were helpful for justifying the information with their audience. This person explained,

> having that back up of "okay it's not just from us, here's this NASA-researched resource you can use, here's this other organization that's sharing it," just being able to have those resources—even though scientifically you know that that is correct but being able to give yourself that background and support. (#4)

Overall, interview data support the finding that professionals gained knowledge of non-NISE Network resources through SEISE, especially in terms of NASA-related assets.

8. Discussion

8.1 Summary of findings

This longitudinal study shows that the SEISE project successfully increased professionals' use of public engagement best practices and fostered relationships and collaborations to support Earth and space informal science education opportunities. Through *Explore Science: Earth & Space* toolkits, the *Sun, Earth, Universe* exhibition, and professional development offerings, the SEISE project reached thousands of professionals and enhanced their Earth and space education efforts. The following summary provides an overview of the main findings from this report, with Sections 8.2 and 8.3 further discussing how aspects of the SEISE project contributed to these results.

SEISE reached thousands of professionals and built a supportive community focused on Earth and space public engagement.

The SEISE Project Professional Impacts Summative Evaluation found that the project reached over 21,000 professionals and volunteers involved in events or professional development on NASA SMD topics. Data from five surveys and two rounds of interviews illustrated how the SEISE project helped professionals feel part of a larger community engaged in Earth and space. In particular, professionals participating in SEISE reported feeling more connected to the NISE Network. They emphasized benefiting from the efforts of the hub leaders and from the ability to meet, learn from, or share with other professionals involved in the project. Professionals noted that SEISE's online workshops and 2019 in-person Partner Meeting were especially valuable venues for these interactions and mutual learning.

Professionals collaborated with others around Earth and space and found the SEISE materials to be helpful for their partnership work.

Data from this study show that not only did the SEISE project reach many thousands of professionals, but that the individuals who participated in SEISE collaborated with a wide variety of community organizations and SMEs in order to engage audiences in Earth and space content. These partnerships included academia, amateur astronomy groups, schools, libraries, and others. Interview data emphasized how the SEISE materials and training resources were seen as particularly useful when professionals collaborated with outside partners from these different types of organizations.

SEISE contributed to professionals' knowledge of Earth and space science and their confidence in conveying this content.

This evaluation illustrated how, besides enhancing professionals' public outreach partnerships, the SEISE project supported professionals' understanding of Earth and space content and their confidence in their ability to convey this information to public audiences. By taking part in SEISE, professionals grew significantly more confident in facilitating content related to all four SMD areas including astrophysics, Earth science, heliophysics, planetary science, as well as the societal dimensions of these topics. Often during interviews, professionals mentioned that the SEISE resources, including the toolkit activities and the exhibition, helped them engage audiences in all of the content areas related to Earth and space. In particular, this study found that SEISE had a strong impact on professionals' confidence and practices around the topic area of "solar systems and planets around other stars." Data indicate that professionals' confidence in this content increased significantly and that, as compared to other SMD topics, this was the content area that professionals were presenting more frequently and were using NISE Net materials for the most.

Professionals used SEISE products in many different ways and increased their ability to use informal STEM learning practices when presenting Earth and space topics.

Finally, this evaluation showed that professionals used SEISE products in a variety of ways, but most often for table top activities and event programming. During surveys and interviews, professionals noted how SEISE resources had been useful for events related to the solar eclipse in 2017 and to the Apollo 50th anniversary. Professionals also reported connecting with a variety of audiences for Earth and space programming and significantly increasing their efforts with diverse or underserved audiences over the course of the SEISE project. Beyond using SEISE materials as part of the project, professionals reported that their participation significantly increased their ability to implement broader informal learning practices such as addressing societal content, talking about common Earth and space misconceptions, and using non-NISE Network materials, such as NASA resources.

Taken together, these results show that the project's support and various offerings led to increased professional use of SEISE resources, understanding of Earth and space content, and partnerships related to these topics. These successes were supported by the fact that the SEISE project built on the already existing Nanoscale Informal Science Education Network and was able to refine and extend the Network's model for engaging professionals. The following sections discuss how each of these areas helped lead to the findings in this report.

8.2 The SEISE project built on the Nano NISE Network.

The SEISE project's success in impacting professionals was in part due to its leverage of the existing infrastructure and capacity of the Nanoscale Informal Science Education Network (Nano NISE Net). From 2005 to 2017, the Nano NISE Network created a Network community and distributed materials and professional development focused on nanoscale science to institutions and individuals across the country. The mechanisms put into place over the course of the Nano NISE Network, including NanoDays events, and the experience of the project team certainly gave SEISE a strong foundation. For example, the Nano NISE Network had an existing community of ISE professionals who could benefit from Earth and space resources and who were familiar with the Network and with the type of products it offered to participants. While additional effort was put into recruiting new partners and planetariums, SEISE was able to build on the large, existing base of professionals in the Nano NISE Network and ultimately to reach over 21,000 professionals and volunteers involved in Earth and space science. SEISE also relied on hub leader roles originally created as part of the Nano NISE Network to help communicate with partners. Findings from this study show that hub leaders were an important piece of the Network's structure and that the SEISE project was successful in building a welcoming Network focused on Earth and space.

Moreover, SEISE drew on the Nano NISE Network's strengths in creating and distributing small footprint exhibitions and toolkits, including various hands-on activities, to a large number of institutions across the country. Due to the expertise developed during the Nano NISE Network, the SEISE team was able to apply lessons learned and work in condensed timeframes to create in the span of five years four toolkits and 52 copies of a 500-600 sq ft exhibition, which ultimately reached 513 institutions. Based on practices started in the Nano NISE Network, SEISE prototyped and gathered feedback from the public during the development phase to create high quality educational experiences. SEISE also worked to ensure that the materials conveyed accurate content about Earth and space by connecting with SMEs to confirm that the information was correct and incorporated up-to-date work being done through NASA. This level of attention to detail and quality allowed even professionals who had come in with high levels of knowledge to significantly increase their confidence in facilitating the SMD content areas. Additionally, as had been the case in Nano NISE Network, in order to make the activities broadly accessible, the team made sure to design them with Universal Design principles in mind and to offer materials in English and Spanish. These factors seemed to support the fact that,

over the course of the SEISE project, professionals reported that they more frequently engaged a variety of audiences in Earth and space programming.

The ability to build on the Nano NISE Network's structures and processes resulted in high quality materials, which was another key reason why SEISE had such a positive impact on participating professionals. Like the Nano NISE Network, SEISE continued to include all materials necessary for the activities and to share training guides and videos. This report illustrates how professionals appreciated the thoroughness of the toolkits and the ability to use SEISE resources with their community or SME partners. In particular, professionals described the Network's training resources as helpful when connecting with partners who may have been less familiar with engaging audiences. Professionals reported that the kits and their supplemental materials helped with their own professional development and growth as well. Indeed, the ease of using SEISE resources may have been one reason why professionals who received a toolkit often did more events than just the required one. Findings from this evaluation study show that the SEISE products and resources catalyzed professional growth and enhanced professionals' knowledge, supported their partnerships, and were used to successfully engage audiences in Earth and space.[35]

8.3 The SEISE project refined and extended the Nano NISE Network's model for engaging professionals.

With the foundation of the Nano NISE Network, the SEISE project was able to advance public engagement with Earth and space science, reach more professionals, encourage new collaborations, and support partners' use of informal STEM learning practices. The SEISE project employed several strategies for carrying out this work including targeting new partners. In order to reach these new professionals, the SEISE project put a great deal of effort into connecting with individuals who could use its Earth and space materials. This included reaching out to a new group of professionals from planetariums across the country. The various new connections helped the SEISE project increase its reach, especially because the project went from creating 250 kits to 350 kits in Years 4 and 5.

Beyond reaching a large number of individuals, SEISE was able to expand professional development opportunities that had started under Nano NISE Network and encourage connections with other professionals in the Network. Over the course of the project, SEISE regularly offered online workshops covering a range of relevant topics. Besides delivering over 40 online workshops, SEISE brought professionals together for a 2019 in-person meeting and offered various materials that were helpful in increasing their confidence in Earth and space content and for connecting them to a larger community engaged in this work. As part of these professional development efforts, the SEISE project put specific emphasis on providing opportunities for professionals to connect with one another. The consistent online workshop offerings and the in-person Partner Meeting allowed professionals to share their expertise and Earth and space experiences with other attendees. Data from this study underscore that professionals valued these opportunities for hearing what others in the field were doing and for learning ways that they could enhance their own programs. These professional development experiences also contributed to the sense of community that professionals noted was such a strong part of the SEISE project.

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[35] To better understand the impacts of SEISE products on the public, see the "*Explore Science: Earth & Space* activity toolkits summative study (https://www.nisenet.org/catalog/explore-science-earth-space-activity-toolkits-summative-study-2019) and the "Summative evaluation of the *Sun, Earth, Universe* exhibition (2020) (https://www.nisenet.org/catalog/summative-evaluation-sun-earth-universe-exhibition-2020).

Another way that the SEISE project extended work that had started during Nano NISE Network was to continue encouraging museums to have events that brought in outside partners and collaborators. For the SEISE project, the Network emphasized building relationships with NASA-related SMEs. Efforts on the part of SEISE to introduce professionals to individuals such as Solar System Ambassadors likely added to the number of partnerships that professionals reported as part of this study. SEISE also influenced professionals' community partnerships by sharing ways for professionals to use project materials to connect with local community partners such as libraries and Girl Scouts.

Finally, the SEISE project aimed to encourage several informal learning practices that could support public engagement in Earth and space science. From the beginning, SEISE incorporated societal connections, such as implications of space research, in their products and in their facilitation guides as a way to help convey information about these complex scientific topics. Societal content had been included in the Nano NISE Network project, and SEISE worked hard to embed this information into their products from the start. Findings from this evaluation underscore the success of these efforts and show that after being involved in the project, professionals were significantly more confident in their ability to engage audiences with societal content related to Earth and space science. SEISE also recognized that there was a need for Earth and space science to address common misconceptions. Thus, SEISE created various products and professional development resources to support individuals' practices in this area. As a result of this work, professionals reported being significantly more confident in their ability to talk about difficult concepts, such as climate change. In addition, interview data highlighted how professionals were engaging their audiences in rich and challenging conversations around Earth and space science. These conversations point to the success of the SEISE products and professional development in supporting professionals' integration of these practices into their work. Throughout the project, SEISE pointed to a variety of Science Activation and NASA resources, which helped contribute to the fact that, after taking part, professionals were significantly more confident in being able to identify, use, and adapt non-NISE Network materials. Overall, it is evident that the SEISE project's strong emphasis on broader informal STEM learning practices supported professionals' ability to engage audiences in Earth and space topics.

9.0 Conclusion

The SEISE Project Professional Impacts Summative Evaluation study looked specifically at change over time in professionals' confidence in SMD content areas and use of informal learning practices encouraged by the Network. The study also looked at how many professionals were reached in Years 1-5 of the project, their use of SEISE products, and how taking part in SEISE impacted their collaborations related to Earth and space science. Five surveys and a series of two interviews were used to gather longitudinal data to better understand professionals' experiences in the SEISE community and the impacts of the project on their work. The study responded to the COVID-19 pandemic by adjusting the final annual partner survey and second round of interviews. A summary of findings related to institutions' virtual and in-person 2020 offerings, use of SEISE products, and how the Network supported professionals during this time can be found in Section 10: COVID-19 Addendum.

Overall, findings from the SEISE Project Professional Impacts Summative Evaluation study indicate that the SEISE project reached over 21,000 professionals and volunteers. Professionals felt significantly more connected to the Network after participating in SEISE and valued the opportunities offered by the project. Not only did they report that hub leaders were an important reason why they felt welcomed, but professionals showed significant growth in being able to meet, learn from, or share with others. Professionals partnered with both community organizations and subject matter experts to engage audiences in Earth and space science and felt that the SEISE materials and training resources enhanced these collaborations. As part of the SEISE project, professionals' confidence in facilitating SMD content areas significantly increased over time, and they used SEISE materials to convey each of the content areas related to Earth and space. In addition, institutions used their toolkits beyond the required events and significantly increased their programming for diverse or underserved groups over the course of the project. Participation in the project also significantly increased professionals' ability to address societal content, talk about common Earth and space misconceptions, and use non-NISE Network materials.

As mentioned in the Discussion, two key aspects of the SEISE project helped lead to these successes: 1) the ability to draw from the structures, processes, and similar type of products developed as part of the Nanoscale Informal Science Education Network; 2) the refinement and extension of the Nano NISE Network's model for engaging professionals and supporting their Earth and space public engagement. These efforts included targeting new partners, enhancing professional development offerings, and encouraging new collaborations and informal STEM learning practices.

Together, these findings and reflections on the success of the SEISE project suggest several implications for new initiatives aimed at supporting professional practice in the ISE field. In particular, because SEISE was effective at creating useful materials and finding ways to connect people, it offers proven strategies that could be adopted by other projects. Findings from this study and previous evaluation studies of the NISE Network underscore that flexible, high-quality materials are vital (Goss et al., 2016; Bequette et al., 2017). Because the SEISE materials were thorough, user-friendly, and came with a variety of training resources and guides, they allowed professionals to easily engage the public in diverse settings and to collaborate with partners. Moreover, to effectively communicate about Earth and space science and reach a wider audience, the SEISE project pushed the field's work by intentionally including bilingual assets and information on how to address societal issues and common misconceptions related to Earth and space science. Other projects can learn from SEISE's materials to support the needs of ISE professionals and carry out ambitious goals.

Besides looking to the well-constructed and accessible SEISE materials, other projects should consider how to connect professionals in ways that allow them to share their knowledge and create meaningful relationships. The NISE Network found success facilitating regional

connections through a hub structure. This mechanism grew out of the Nanoscale Informal Science Education Network and was again beneficial for disseminating information and making connections between SEISE participants. Additionally, findings from this study highlight how the Network provided powerful peer-to-peer learning opportunities, whether through online workshops or in-person meetings. Other projects aiming to influence professionals' practice could be strengthened by allowing their participants to engage in mutual learning similar to the work of the SEISE project.

The findings from the SEISE Project Professional Impacts Summative Evaluation also suggest directions for future studies. While this project looked holistically at the SEISE offerings and how they influenced professionals, future efforts could investigate specific aspects of their materials, such as the flexible nature, the inclusion of particular focal points, or the amount of exposure professionals have to them, to better understand how characteristics of the resources may support different audiences and outcomes. In addition, future studies could look at ways the professional development mechanisms used as part of SEISE could be effectively scaled or replicated to support networks or projects of different sizes.

This evaluation showed that the SEISE project had major impacts on professionals, and therefore, was able to contribute to the NASA Science Activation Collaborative's high-level objectives. The ability of the SEISE project to create toolkits and exhibits and distribute them to all 50 states and several U.S. territories meant that professionals could enable STEM education across the US (for more information about findings see Sections 4-7). Professional development opportunities through in-person meetings and online workshops, as well as through training materials and other resources in the toolkits, led professionals to improve their understanding of NASA content areas such that the SEISE project was able to contribute to US scientific literacy (for more information about findings see Section 6). By engaging large numbers of professionals and volunteers over the course of the five years of the project through events and other kinds of outreach, SEISE supported the advancement of national education goals (for more information about findings see Sections 4 and 7). Finally, by promoting collaboration between professionals and SMEs, the SEISE project was able to contribute to the achievement of the goal to leverage Earth and space work through partnerships (for more information about findings see Section 5). As described in the Discussion, these results were due to many factors including the Network's structure, quality offerings, and welcoming approach toward new partners, collaborations, and practices in order to push the bounds of Earth and space education. The approaches that the Network employed as part of SEISE offer invaluable insights for other projects' professional development efforts.

10.0 COVID-19 Addendum

10.1 Study timing and context

The COVID-19 pandemic caused widespread disruption in the ISE field, including but not limited to institutions closing to the public and changes to how museums and other institutions fulfilled their missions. Due to these changes, the interviews and surveys planned for 2020 were reshaped to understand some of the impacts of the pandemic on professionals involved in the SEISE project. The interviews conducted in August of 2020 provided an initial understanding of how institutions were operating during the pandemic, whether their buildings were open to the public, and how these changes impacted their Earth and space offerings. The 2020 COVID annual partner survey (APS) sent out in October provided a broader sense of institutions' virtual and in-person offerings and use of SEISE products during the past year, along with their thoughts about how the NISE Network community supported them during this time. This addendum provides an overview of what professionals and their institutions' participation in SEISE looked like in the midst of the COVID-19 pandemic.

10.2 Methods

The 2020 interviews were conducted with individuals who had taken part in the first round of interviews for the SEISE Project Professional Impacts Summative Evaluation in 2019. Interviews for the second round were conducted online through Zoom, took approximately 30 minutes, and participants received a $25 Amazon gift card for their time. Ultimately, 12 of the 13 professionals from the first year of interviews participated. The interviews covered COVID-19 related topics along with questions following-up on their previous interview and survey responses. Answers to the COVID related questions were inductively coded and reviewed by the evaluation team. The team then used these findings to inform questions on the 2020 COVID APS, particularly those about virtual and in-person programming formats. Additional details about recruitment and methods for the interviews can be found in Section 2 of the main report.

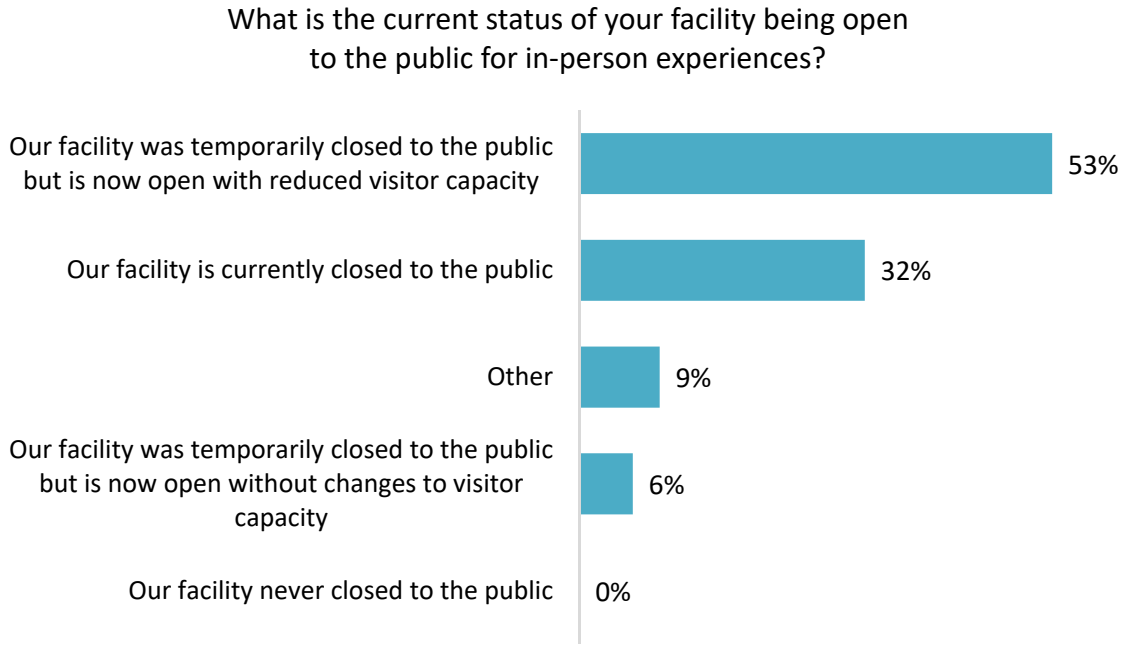
Participants for the 2020 COVID APS were recruited using the NISE Network database, employing the same methods for other surveys in this study, as described in Section 2. It is important to note that in 2020, due to the COVID-19 pandemic, there were major layoffs throughout museums in the United States resulting in high levels of staff turnover that may have affected the accuracy of the NISE Network database. However, the efforts made to update the database meant that it was as accurate as possible during such uncertain times. Eligible individuals included those who had received at least one *Explore Science: Earth & Space* physical toolkit, participated in at least one SEISE-related online workshop at the time of recruitment, or were enrolled in the four-week professional development online workshop series in 2017. The survey was conducted online through Alchemer and took approximately 15 minutes to complete. Ultimately, 195 professionals participated in the 2020 COVID APS. Quantitative findings from the survey are reported in this Addendum through descriptive frequencies. The survey included several open ended questions that were inductively and deductively coded and reviewed by the evaluation team for overarching themes. Summaries from the qualitative questions are accompanied in this Addendum by representative quotes.

10.3 Institutional status

All institutions were closed at some point during the pandemic. As shown in Figure 19, at the time the survey was administered in October 2020, a third of professionals (32%) reported that their institutions were still completely closed to the public. However, about half of professionals (53%) reported that their institutions had closed temporarily but were currently operating at reduced capacity. A small number of professionals (6%) indicated that their institutions had

since re-opened at normal capacity. Besides these options, professionals were given an opportunity to explain any other type of operational circumstances, and a few (9%), wrote-in that their institutions were mostly closed to the public but had outdoor-only or limited indoor events or programs. In addition to these operating changes, two-thirds of professionals reported that the staffing levels at their institution had decreased since March 2020. These data provide useful context for understanding how professionals used SEISE materials during 2020.

Figure 19: *Institutions' operational status in October 2020 at time of survey. 2020 COVID APS, N=195*



10.4 Programming and product Use

Due to operational changes during the pandemic, institutions adapted their programming to continue to serve their audiences. Interviewees shared a range of strategies they employed to adjust their general STEM programming, including moving their offerings to virtual platforms or providing take-home activities for the public. Survey responses mirrored interviewees' comments about the types of changes that were made to both virtual and in-person programming at their institutions. When talking more specifically about Earth and space programming, interviewees mentioned using formats similar to those undertaken with other topics, but they noted that it felt more difficult to transition this content area to virtual or COVID-safe experiences as compared to their chemistry or biology offerings. The following sections highlight the survey data about institutions' virtual and in-person programming around Earth and space science.

10.4.1 Virtual programming

Between March and October 2020, almost all professionals (91%) reported that their institutions were offering at least one new virtual format for their Earth and space programming, in response to widespread reduction of in-person experiences during the pandemic. Besides offering completely new virtual opportunities, some institutions were using a few virtual formats that they had used prior to the pandemic more frequently, as shown in Figure 20.

Overall, many professionals reported that their institutions started using a wide variety of new virtual formats for Earth and space related experiences traditionally offered in-person. In particular, online programming with educators (hands-on activities, demos, presentations, story time, etc.) were reported by 61% of professionals as completely new virtual formats for their institutions, while virtual events (star party, Earth Day, etc.) were completely new for 45% of institutions. Professionals also shared that their institutions had started to offer completely new virtual website activities including online exhibits, videos, or activities (39%), virtual camps (39%), or virtual tours (38%). For each of these completely new formats, over 70% of institutions expected them to continue throughout the pandemic.

However, virtual formats for Earth and space content were not completely new territory for all institutions. Almost all professionals (94%) indicated that their institutions had previously done some amount of sharing content on social media and were continuing to do so during the pandemic. For this question, many professionals noted their institutions were either sharing content on social media more frequently (57%) or at about the same level as before COVID (28%). Some professionals also reported that their institutions were offering more virtual website activities on top of what they had done before (27%). While some professionals reported that their broadcast media interviews or programs were completely new (5%), many were offering the same frequency of this type of program (29%) or had increased to more than before (14%). These data show that in adapting Earth and space programming to a mostly virtual landscape, institutions not only used a variety of new formats but also expanded virtual offerings they had previously employed.

As schools shifted to teaching virtually, institutions also offered new ways to support their in-school or out-of-school efforts with Earth and space programming. In particular, about half of professionals (51%) reported that their institutions were offering completely new support for virtual pre-K to 12 school efforts, while an additional 13% had increased how often they were offering this format. Institutions were also offering virtual support for afterschool or out of school programs, with 44% of professionals saying this was a completely new experience for their institutions. Some professionals shared that their institutions had previously offered these types of virtual formats but were doing more out-of-school support (6%) during this time. Over 84% of institutions expected to keep offering these formats during the pandemic to support school efforts.

In addition to the list of formats provided on the survey, a few professionals shared other types of virtual programming their institutions were offering. Write-in responses to this question included mentioning a hybrid model, kits, or hands-on materials that could be used with virtual programming, subscription based programming, and direct email communication.

In Figure 20 below, dark green indicates completely new virtual formats that institutions were using for their Earth and space programming, while light green indicates virtual formats that institutions had previously offered but were using more frequently during the pandemic. For a couple of areas, professionals reported that their institutions were continuing to use virtual formats at about the same frequency as they had prior to the pandemic, as indicated in blue.

Figure 20. *Virtual programming formats offered by institutions. 2020 COVID APS, N=195*[36]

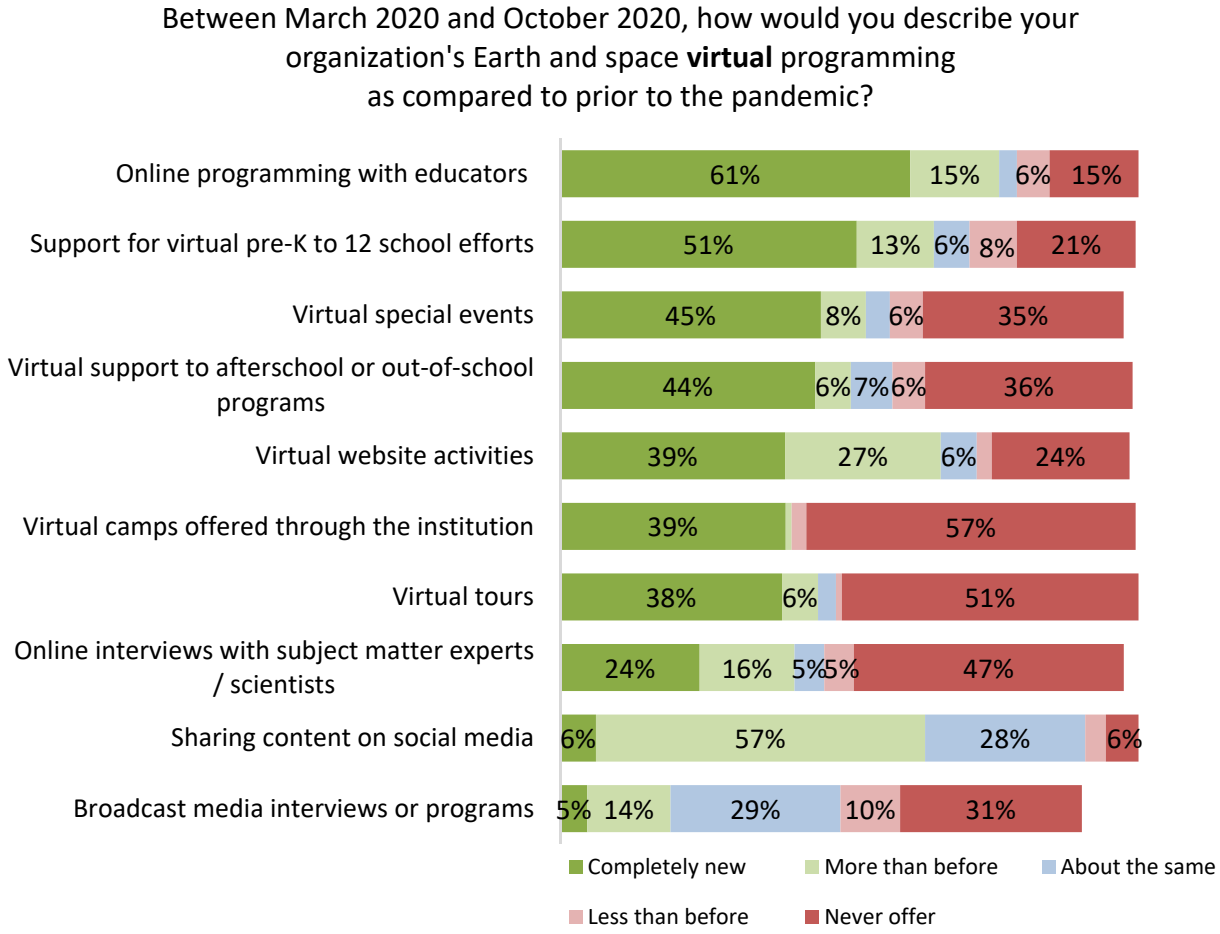
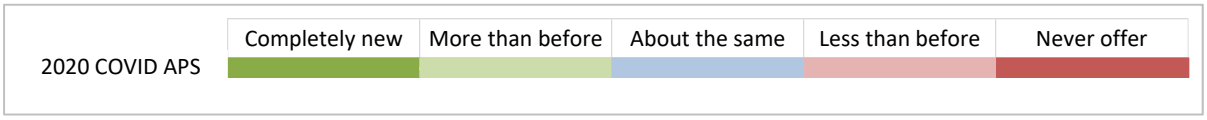


Figure Key



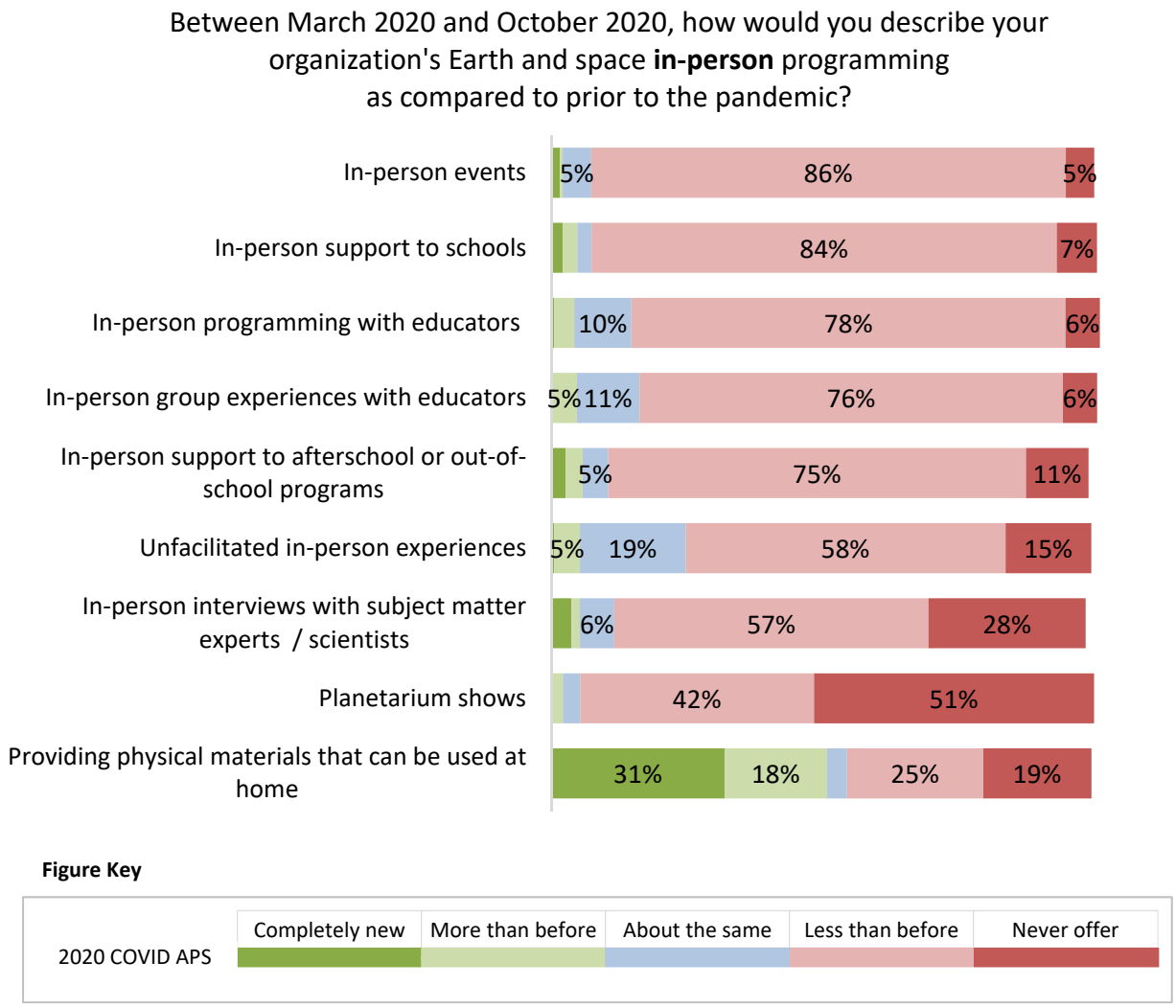
10.4.2 In-person programming

Overall, institutions were offering fewer in-person experiences for their Earth and space programming between March 2020 and October 2020 than before the pandemic. As shared in Section 10.1, all institutions were closed at some point during the pandemic, and often when they did reopen, it was at a reduced operating capacity. Not surprisingly, considering the wide-spread recommendations for social distancing, experiences that required close proximity to others were being offered less frequently. The main in-person experiences that were affected and being offered less often included events (86%), support to schools (84%), and programming or group experiences with educators (78% and 76%, respectively). However, as can be seen in Figure 21, professionals reported that institutions were experimenting with offering physical materials that can be used at home (31% completely new) or pursuing this type of programming more often (18% more than before). Many professionals (72%) expected that offering physical

[36] Labels for values smaller than 5% have been removed from the figure to increase readability.

materials for at home use would continue to be an in-person format used throughout the pandemic.

Figure 21. *In-person programming formats offered by institutions. 2020 COVID APS, N=195*[37]



10.4.3 Using NISE Network materials

Professionals indicated that usage of NISE Network materials to support their Earth and space work during 2020 depended on the format of the offering. Many institutions (62%) were using Network materials for at least one type of virtual programming. The virtual formats where Network materials were most commonly used were for online programming with educators (49%), virtual camps (44%), and virtual support for afterschool/out of school programs (40%). Institutions used NISE Network resources less often for virtual tours (10%), broadcast media interviews or programs (8%), or online interviews with SMEs (8%). These findings are not surprising as the NISE Network materials were not designed with these formats in mind.

More than half of professionals (56%) said their institutions used NISE Network materials for at least one of their in-person offerings that occurred in 2020, whether it was on-site or as part of a

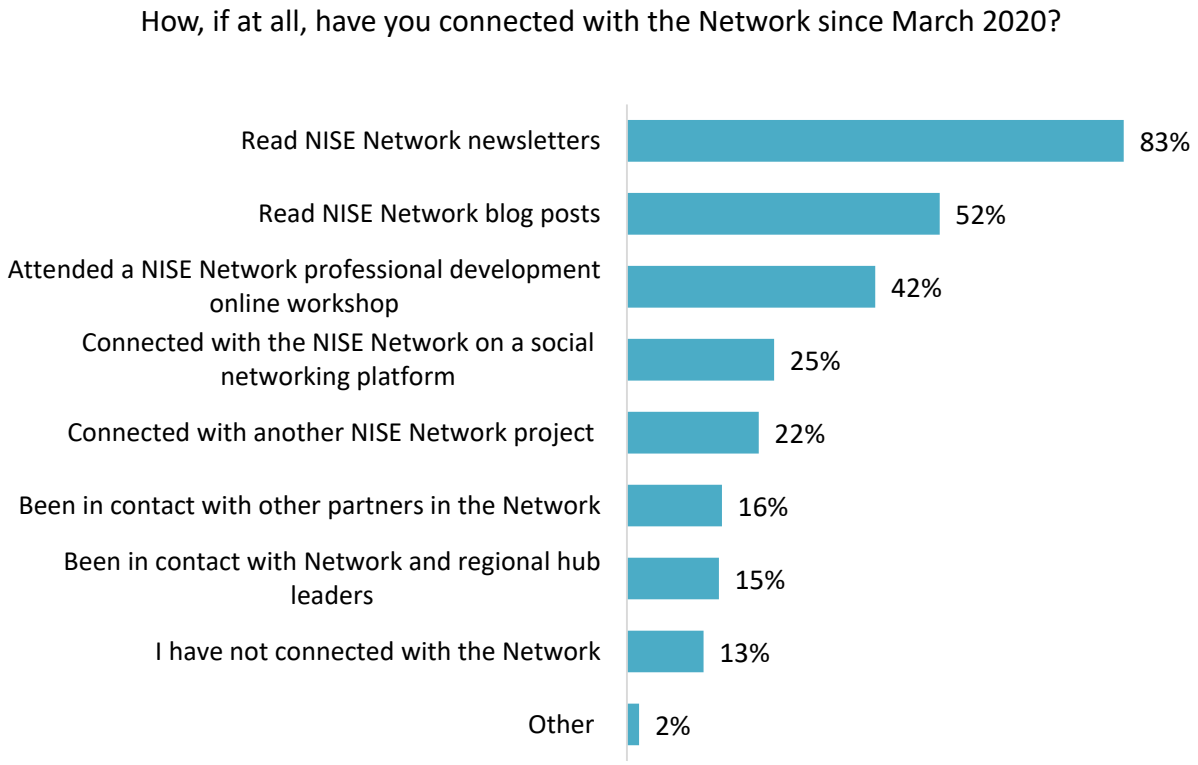
[37] Labels for values smaller than 5% have been removed from the figure to increase readability.

hybrid model. The in-person formats that institutions used NISE Network materials for included providing physical materials to use at home (41%), in-person programming with educators (38%), and in-person group experiences (37%). The set-ups for these different activities may have involved providing materials that visitors could use at home when watching a virtual educator or using the NISE Network materials, including the exhibition, safely with social distancing. The toolkits and exhibition created by the Network were designed to be hands-on and interactive, so it is not unexpected that they continued to be offered in this way, when it was safe to do so.

10.5 Community

Most professionals (87%) had connected with the Network in some way since March 2020. When asked about the different ways they had connected, professionals indicated that interactions with the Network had happened most often through reading the newsletters (83%), blog posts (52%), and/or attending online workshops (42%). Many professionals also reported that during the pandemic they had interacted with the NISE Network on a social networking platform (25%) or connected with another NISE Network project, such as ChemAttitudes (22%). Additional ways that partners connected with the NISE Network are shown in Figure 22.

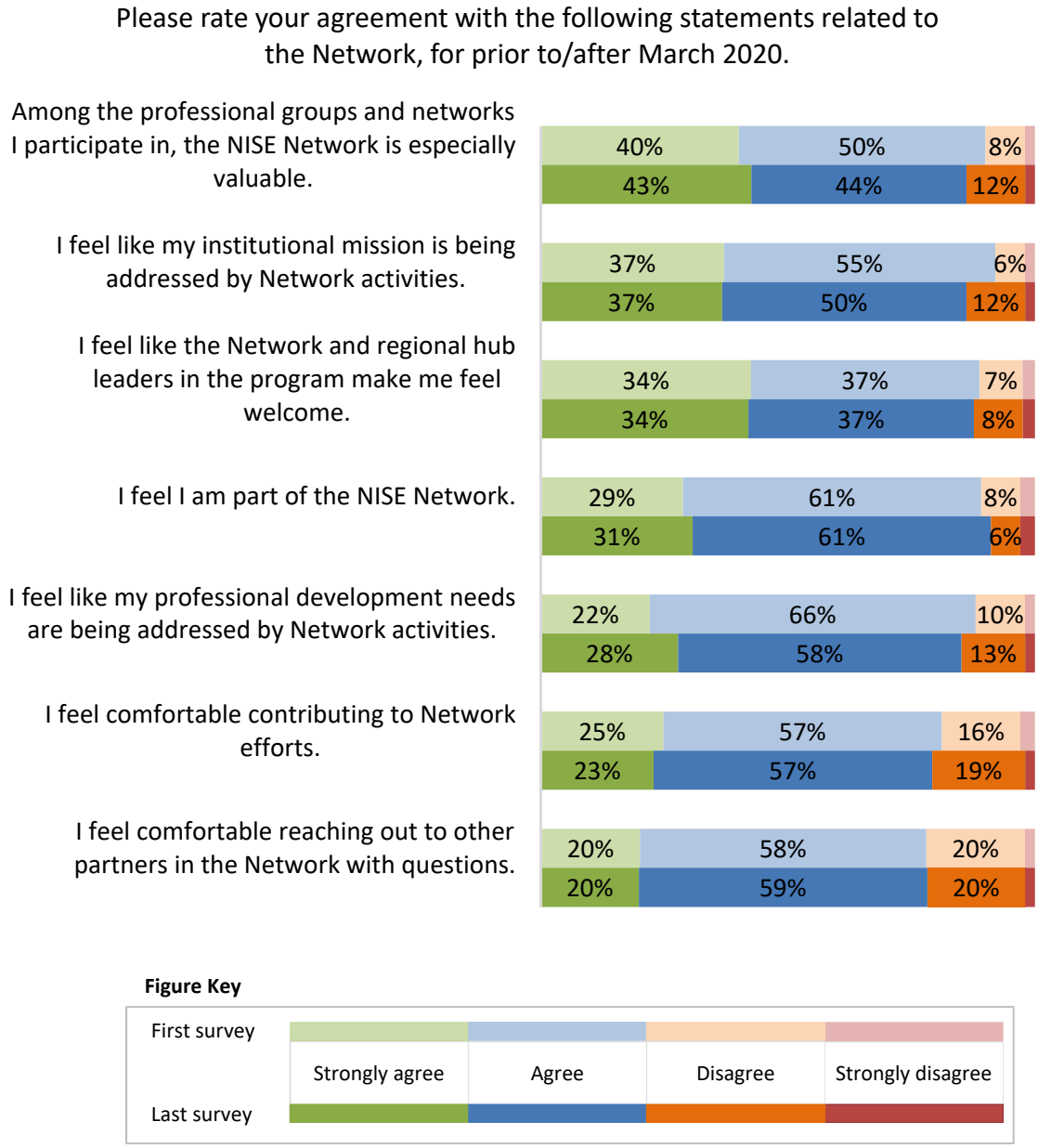
Figure 22: *Professionals' interactions with the Network. 2020 COVID APS, N=195*



Professionals were also asked to rate several statements about their feelings towards the Network prior to March 2020 and after March 2020. At least 79% of professionals "agreed" or "strongly agreed" with each of the statements after March 2020. In particular, many professionals "strongly agreed" that "among the professional groups and networks [they] participate in, the NISE Network is especially valuable (43%), "[their] institutional mission is being addressed by Network activities" (37%), and "the Network and regional hub leaders in the program make [them] feel welcome" (34%), see Figure 23. While no statistical differences were

seen between the two timeframes, these findings indicate that the Network kept professionals engaged during a turbulent time.

Figure 23. *Professionals' ratings about their feelings towards the Network during the pandemic. 2020 COVID APS, N=188*[38]



When explaining how their interactions with the Network impacted their feelings, professionals' emphasized that their interactions had a positive effect on them, especially due to the Network's sharing of useful resources, offering opportunities to connect, and providing general support.

[38] "I feel comfortable reaching out to other partners in the Network with questions," "I feel like the Network and regional hub leaders in the program make me feel welcome," "Among the professional groups and networks I participate in, the NISE Network is especially valuable" n=189; I feel like my institutional mission is being addressed by Network activities" n=186.

Labels for values smaller than 5% have been removed from the figure to increase readability.

Overall, professionals (n=49) commented on how appreciative they were of the resources and guidance that the NISE Network gave related to programs and activities, including virtual experiences. As one individual said, “I really appreciated all the ideas and examples of COVID resources that were available and am now just getting to use in my small planetarium.” Many professionals (n=38) mentioned the networking opportunities and connections that the Network offered, especially describing how helpful it was to hear what others were doing during COVID. One professional stated, “I am thankful for the connections and support offered by the network when we were all isolated. It help[ed] give us perspective about how what was happening to us was similar or different than what was happening with others.” Another individual wrote how “I always appreciate any opportunity to connect with colleagues, but during this time it has felt especially crucial, as not a one of us has all the answers and it is immensely helpful to learn from what others are doing or just sort through ideas.”

In response to this question about connecting with the NISE Network, several professionals (n=25) thanked NISE Network generally for their efforts and praised the fact that the Network had continued to reach out to them during this difficult time. One individual summarized their feelings by saying, “It's positive to know that we aren't alone and that NISE was being responsive to current events.” Survey respondents (n=20) also commented on how appreciative they were of the professional development opportunities offered by the Network, including the newsletters that allowed them to stay informed and the online workshops where they could learn and share ideas. As one individual noted,

> The NISE Net meetups were some of the most useful and valuable of all the many meetups I attended while we were shut down! I so appreciate all of the really great organizations and educators I got to connect with at these meetings. It helped shape my [department] as we made our own plans to reopen.

While several respondents (n=21) said that their feelings toward the Network had not changed, many of these individuals indicated that their feelings had already been positive. Additionally, a small number of professionals (n=8) noted valuing the direct communication from Network leadership and the Hub Leaders, with a few specifically citing the check-in emails sent during the pandemic. Some professionals referenced the flexibility of the NISE Network concerning deadlines and the use of awarded kit materials. Others (n=5) also mentioned appreciating the toolkits, in general, when explaining how connecting with the NISE Network had impacted their feelings towards the Network in 2020.

When asked how the NISE Network could support them during this time, professionals were often seeking support for adapting to the new ISE landscape. Many people (n=33) mentioned that it would be helpful for the Network to provide additional toolkit materials or adjust the current toolkit or exhibition to be more COVID-friendly. As one individual described, they were looking for "More opportunities to replenish kit materials to be packaged for at-home learning kits." Similarly, many people (n=28) also suggested that the Network offer more programs, activity ideas, or guidance especially related to virtual or COVID-related programming options. For example, one professional wondered if the Network could “provide online programming that we can share via social media.” Other individuals (n=12) felt that the NISE Network could highlight materials or guidance for different audiences such as small children, home audiences, or schools. Some participants (n=6) wanted continued flexibility on the part of the Network related to the use of toolkit materials, with one individual asking for "patience with us for not using the materials to their full potential."

Professionals also talked about ways that the Network could help maintain opportunities to connect and learn from each other. Many partners (n=27) said that the NISE Network should continue to offer ways for partners to interact, with over half of these individuals (n=16) mentioning that it was especially useful to hear what others were doing during COVID. In

addition, many (n=26) said the Network should continue to have professional development opportunities such as the online workshops or newsletters that share information. One individual voiced this idea by saying the Network should "continue with the webinars, emails, and other opportunities to connect, collaborate, and partner." Moreover, some people (n=8) appreciated the direct communication from NISE Network Hub Leaders and leadership and hoped these aspects would continue.

Finally, a few individuals (n=5) highlighted how they needed funding opportunities or would welcome help identifying potential sources. And, while some individuals did not have a suggestion (n=15) or said that they were still closed to the public (n=6), many individuals (n=32) took this opportunity to thank the Network for being there and carrying out its work during the pandemic. One professional, in expressing thanks summarized their thoughts by saying, "Continue to do an amazing job! Very grateful for this Network and all it has to offer."

10.6 Conclusion

In 2020, Year 5 of the SEISE project, the COVID-19 pandemic impacted partner institutions and the ways they engaged audiences in Earth and space science. Changes included disruptions to how partner institutions operated, the types of Earth and space related programming they offered, how they used SEISE resources, and how they interacted with the NISE Network. All of the institutions were closed at some point during the pandemic, and by October 2020 a third were still closed, while about half had reopened at reduced capacity. Additionally, two-thirds of institutions reported reduced staffing since the beginning of the pandemic.

Between March and October 2020, partner institutions started decreasing their use of in-person formats due to safety concerns and started or continued using a wide variety of virtual formats to engage audiences with Earth and space science. For many institutions, traditional museum experiences transitioned to new virtual formats, such as online programming with educators or events that took advantage of virtual platforms to reach audiences. Many professionals also shared that they were offering new virtual support for schools. While most institutions were offering fewer in-person experiences, some institutions started to offer take-home kits for their audiences to use at home. For any of these new and more frequently used virtual or in-person formats, most professionals expected their institutions to continue offering these experiences during the remainder of the pandemic. Despite changes in how institutions were presenting Earth and space science, over half of professionals reported that they had used NISE Network materials for at least one virtual (62%) or in-person (56%) format. Although it was evident that SEISE materials were being used despite the changes institutions made in response to the pandemic, there are opportunities for the Network to consider new ways to support partner institutions, especially if the influence of COVID-19 encourages continued use of these new in-person or virtual experiences in the future.

Finding from this evaluation showed that most professionals connected with the Network in some way during this time frame, typically through reading newsletters or blog posts or by attending online workshops. During 2020, professionals appreciated that the Network offered useful resources and opportunities to connect and learn from other professionals during COVID, in addition to general support. Through their interactions with the Network, professionals continued to feel that the NISE Network was valuable, their institutional mission was being addressed, and that they felt welcome. Despite a turbulent and uncertain landscape for ISE institutions, the sense of community within the Network remained strong.

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Appendix A: Online Workshops

The SEISE project provided regular online workshops over the course of the grant that were free to attend and recorded so that they could be watched at a later date. The hour-long workshops covered a variety of topics to support professionals' use of the toolkit activities, understandings of Earth and space content, their informal STEM practices, and partnerships. Over the timeframe of the professional impacts study, from 2016 through October 2020, a total of 43 one-hour workshops were held, some of which are referenced throughout the report as examples of the SEISE project's professional development offerings. The list of online workshops below provides the 43 titles and how each one aligned with the aspects discussed in this report. These areas include partnerships (Section 5), Earth and space content (Section 6), toolkit use (Section 7), and informal STEM practices (Section 7). Additional SEISE workshops that were offered after the study's data collection timeframe are not included here. All of the SEISE project's online workshops are recorded and archived on the NISE Network website, along with online workshops from other NISE Network projects: www.nisenet.org/online-workshop-recordings.

2016-2017 Online Workshops

Online Workshop Title	Partnering	Earth and space content	Toolkit use	Informal STEM practices
Explore Science: Earth & Space toolkits			X	
Finding and Collaborating with Astronomy Experts and Volunteers	X			
Tips for Planning Your August 21, 2017 Solar Eclipse Event	X			
What's in Your Explore Science: Earth & Space Toolkit 2017			X	
The Science Behind the Earth and Space Toolkit: Astrobiology - Searching for Life		X		
The Science Behind the Earth and Space Toolkit: The Changing Earth		X		
Working through Difficult Concepts in the Explore Science: Earth and Space Toolkit		X		X
An Online Discovery of NASA and Other Earth and Space Related Resources		X		X
Streaming the Eclipse: How to Utilize Online Live Streams at Your Eclipse Event	X			
Join the Eclipse Party! What are You Doing to Celebrate the August 21st, 2017 Total Solar Eclipse?			X	
Learn More About the 2018 Explore Science: Earth & Space Toolkit			X	
Museum Community Partnerships - Part 1: Libraries	X			
Museum Community Partnerships - Part 2: Girl Scouts	X			

2018 Online Workshops

Online Workshop Title	Partnering	Earth and space content	Toolkit use	Informal STEM practices
Museum Community Partnerships - Part 3: Working with the Solar System Ambassadors and Night Sky Network	X			
What's in Your 2018 Explore Science: Earth & Space Toolkit			X	
The Science Behind the 2018 Explore Science: Earth and Space Toolkit - Exploring Earth and the Solar System		X		
The Science Behind the 2018 Explore Science: Earth and Space Toolkit - Looking Beyond the Solar System		X		
NGSS and the Explore Science: Earth & Space Toolkit - Connecting Your Toolkit to Field Trips and K-12 Programs			X	
Changing the Conversation About Climate		X		X
Museum Community Partnerships - Afterschool Programs: Advocating, Collaborating and Bringing Earth and Space Content to Out-of-school Time	X			
Be Prepared: Safety Tips and Reminders for Museums Running Public Events, Including National Chemistry Week and Earth and Space Events			X	
Girl Scouts and STEM: New Space Science Badges and Opportunities to Connect with the Explore Science: Earth & Space Toolkits	X			
Explore Science: Let's Do Chemistry Kit & Celebrate National Chemistry Week (October 21-27, 2018)!			X	
Learn More About the 2019 Explore Science: Earth & Space Toolkit			X	
Celebrating the Moon, Our Nearest Neighbor in Space	X			
Deepening and Extending Family Engagement and Learning Through Interactive Exhibits and Facilitated Hands-on Activities			X	
Extending Your Earth & Space Science Exhibits - Free Multimedia Resources from NASA's Universe of Learning, NASA's Eyes, and the NISE Network	X	X		X

2019 Online Workshops

Online Workshop Title	Partnering	Earth and space content	Toolkit use	Informal STEM practices
New to the NISE Network? Getting Familiar with Network Resources, Partners, Projects, and Events			X	
The Science Behind the 2019 Explore Science: Earth and Space Toolkit - Exploring Earth and Our Solar System		X		
The Science Behind the 2019 Explore Science: Earth and Space Toolkit – Exploring the Universe		X		
Celebrate Earth Day with NISE Net: Activity Connections and How Visitors Can Contribute Local Environmental Observations to NASA Science	X			
Stories & STEM: Explore the Power of Narrative to Engage Audiences and Enliven Hands-on Science Programs				X
Big or Small, Make Your Apollo 50th Anniversary Celebration Events a Moonshot!	X			
Earth & Space Science for Early Learners				X
Learn More About the 2020 Explore Science: Earth & Space Toolkit			X	
Empowering Girls in Science Through Growth Mindset and the New Girl Scout Space Science Badges	X			X
Using Your Explore Science: Earth & Space Toolkit Outdoors: Practical Advice for Collaborations and Logistical Aspects	X			X

2020 Online Workshops

Online Workshop Title	Partnering	Earth and space content	Toolkit use	Informal STEM practices
The Science Behind the 2020 Explore Science: Earth and Space Toolkit – Virtual Tour of a NASA Mission Prototyping and Testing Lab (Part 1)		X		
The Science Behind the 2020 Explore Science: Earth and Space Toolkit – Using Your Toolkit to Present the Life Cycle of Stars (Part 2)		X		
The Science Behind the 2020 Explore Science: Earth and Space Toolkit – Asteroid Mining (Part 3)		X		
Celebrating Earth Day 2020 at Home			X	
Lessons learned from a summer of physically distanced Earth and space public engagement			X	
Museum school outreach and fields trips in the time of COVID uncertainty	X		X	

Appendix B: Learning Framework and Content Map

The SEISE project created a learning framework to help articulate the kinds of learning experiences that they wanted to support for visitors using the *Explore Science: Earth & Space* toolkits or the *Sun, Earth, Universe* exhibition. The project's learning framework was based off of the six strands of science learning developed by the National Research Council and includes key ideas, questions, and ways of experiencing content that would help visitors learn, engage, and grow in informal science environments (King et al., 2020).

The project's content map identified how the NASA Science Mission Directorate content areas (Earth science, heliophysics, astrophysics, and planetary sciences) were approached when being incorporated into the toolkits and the exhibition. In addition, the Network incorporated social dimensions of Earth and space science as an area of interest into its products. For each of these content areas, as can be seen in the content map below, the project identified several key concepts or topics that would be addressed in the public-facing products.

Space and Earth in STEM informal environments learning framework

1) **Experience Earth and space PHENOMENA and explore scientific discoveries**
   a) **Experiencing the joy of active learning, including play, discovery, invention, and experimentation**
      i) Learning is a continuum, which connects and builds on past and future experiences.
      ii) Learners can work alone or in groups to discover new knowledge and build skills.
      iii) Both novices and experts can be excited by seeing or understanding something for the first time.
      iv) Learners can recognize and overcome common misconceptions about our planet Earth and the solar system.
   b) **Experiencing real phenomena, celestial events, and compelling imagery**
      i) We can directly observe and experience many phenomena related to Earth and space science.
      ii) The study of celestial events can spur curiosity and contribute to our personal and collective knowledge.
      iii) The universe can be very beautiful.
   c) **Exploring and understanding our place in the universe**
      i) The universe is very large and can be difficult to conceptualize.
      ii) The universe is always changing: galaxies are colliding, stars are forming and dying, and the Earth and solar system are hurtling through space.
      iii) Space has many dangerous environments that can be harmful to both humans and robotic instruments.
   d) **Investigating the big questions that drive Earth and space research**
      i) How did life on Earth start, and are we alone in the universe?
      ii) How did the universe begin, and how were our galaxy, solar system, and planet formed?
      iii) What protects life on Earth and how do humans change these conditions?

2) **Use the scientific PROCESS and reflect on science as a way of knowing**
   a) **Engineering and scientific research is an iterative design process**
      i) Planning and executing a NASA mission is a long process with many steps.
      ii) Missions do not always go as planned and sometimes have unanticipated results, but all missions provide valuable information that provide data and inform future missions.
      iii) Grand challenges in Earth and space research are often broken down into simpler problems to be tackled one at a time.
      iv) While quantitative methods and critical thinking are important in solving problems,

ingenuity and imagination are also helpful in advancing us to the next stage of knowing.

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

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

c) Understanding the power and limitations of data sets

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

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

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

e) Using our imagination and ingenuity to explore the universe

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

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

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

i) NASA missions involve many different types of people and communities working together over a long period of time.
ii) Mission teams must cooperate, communicate, and take advantage of their diversity of experience, expertise, and perspectives.
iii) Missions require many different tools, instruments, and methods--all designed to work together.
iv) Major discoveries in Earth and space science can take years and years of work by many different people, including scientists and citizens.

b) Recognizing the relevance of Earth and space science

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

c) Considering the social dimensions of Earth and space science

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

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

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

Content map for the Explore Science: Earth & Space toolkits and Sun, Earth, Universe exhibition

The Sun powers Earth and our solar system.

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

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

Planetary systems like ours may contain water and life.

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

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

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

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

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

The universe is very large, old, and mysterious.

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

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

Our society chooses to explore Earth and space.

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

Forces and energy connect everything in the universe.

- Electromagnetic spectrum
- Gravity
- Magnetism

v2/23/18

Appendix C: *Explore Science: Earth & Space* Toolkits

Each of the *Explore Science: Earth & Space* toolkits contained a suite of hands-on activities, along with resources that supported professionals' use of the activities with public audiences. These supporting resources included planning and collaboration guides, promotional materials, facilitations guides, training videos and slides, educational posters and media, and much more. Additional details about the toolkits and their contents can be found at www.nisenet.org/earthspacekit.

Image: Overview of the Explore Science: Earth & Space toolkits

Image [left to right]: Example of toolkit activity with its components, from "Exploring the Solar System: Mars Rovers;" Explore Science: Earth and Space toolkit packaged and ready to ship.

There were 45 total activities between the four *Explore Science: Earth & Space* toolkits, with 35 unique activities. These activities were intentionally designed to cover one or more content and learning framework areas, defined in Appendix B. The tables below highlight which content and learning framework area(s) the toolkit development team felt each activity covered. It is important to note that the 2020 toolkit was shared in two parts, with the 2020 Part B components being sent out after the study's data collection period. Toolkit B had a focus on the Moon and also included the "Moon Adventure Game" funded by a separate NASA project.

Content area(s)
H= Heliophysics
ES = Earth Science
PS = Planetary Science
A(G) = Astrophysics: Galaxies and Beyond
A(F) = Astrophysics: Forces and Energy in the Universe
C = Connections between Earth and space research in our society

Learning framework area(s)
Ph = Experience phenomena
Pr = Use the scientific and engineering process
Pa = Participate in the scientific community

2017 Explore Science: Earth & Space Toolkit

	Content area(s)	Learning framework area(s)
Exploring Earth: Bear's Shadow	H, ES	Ph
Exploring Earth: Investigating Clouds	H, PS, C	Ph, Pr, Pa
Exploring Earth: Rising Seas	ES	Ph, Pa
Exploring the Solar System: Big Sun, Small Moon	H, ES, PS	Ph
Exploring the Solar System: Ice Orbs	PS, C	Ph, Pr
Exploring the Solar System: Pocket Solar System	PS	Ph
Exploring the Solar System: Solar Eclipse	H, ES, PS	Ph
Exploring the Universe: Imagining Life	ES, PS, A(G), C	Pr, Pa
Exploring the Universe: Orbiting Objects	A(G), A(F)	Ph

2018 Explore Science: Earth & Space Toolkit

	Content area(s)	Learning framework area(s)
Exploring Earth: Paper Mountains	ES	Ph, Pa
Exploring the Solar System: Craters	ES, PS	Ph, Pr
Exploring the Solar System: Hide and Seek Moon	PS, C	Pr, Pa
Exploring the Solar System: Magnetic Fields	H, PS, A(F)	Ph
Exploring the Solar System: Mars Rovers	PS, C	Pr, Pa
Exploring the Solar System: Stomp Rockets	H, ES, PS, C	Pr, Pa
Exploring the Universe: Exoplanet Transits	PS	Pr, Pa
Exploring the Universe: Filtered Light	A(G), A(F)	Ph, Pr
Exploring the Universe: Objects in Motion	PS, A(F)	Ph
Exploring the Universe: Pack a Space Telescope	A(G), A(F), C	Pr

2019 Explore Science: Earth & Space Toolkit

	Content area(s)	Learning framework area(s)
Exploring the Universe: Expanding Universe	A(G), A(F)	Pr
Exploring Earth: Land Cover	ES	Ph, Pr, Pa
Exploring Earth: Rising Seas^	ES	Ph, Pa
Exploring Earth: Temperature Mapping	ES, A(F)	Ph, Pr
Exploring the Solar System: Hide and Seek Moon^	PS, C	Pr, Pa
Exploring the Solar System: Observe the Sun	H	Ph, Pr, Pa
Exploring the Solar System: Pocket Solar System^	PS	Ph
Exploring the Solar System: Stomp Rockets^	H, ES, PS, C	Pr, Pa
Exploring the Universe: Filtered Light^	A(G), A(F)	Ph, Pr
Exploring the Universe: Space Guess Quest	A(G)	Pr, Pa
Exploring the Universe: Static Electricity	A(G), A(F)	Ph, Pr, Pa

^Activities were duplicated from an earlier kit.

	Content area(s)	Learning framework area(s)
Part A		
Exploring Earth: Bear's Shadow^	H, ES	Ph
Exploring Earth: Investigating Clouds^	ES, PS, C	Ph, Pr, Pa
Exploring the Solar System: Asteroid Mining	PS	Pa
Exploring the Solar System: Design, Build, Test	PS	Pr, Pa
Exploring the Solar System: Mission to Space	PS	Pr, Pa
Exploring the Universe: Nebula Spin Art	A(G)	Ph
Exploring the Universe: Orbiting Objects^	A(G), A(F)	Ph
Exploring the Universe: Space Guess Quest^	A(G)	Pr, Pa
Exploring the Universe: Star Formation	A(G)	Ph
Science Practice Skills: Early Explorations	ES	Ph, Pr, Pa
Part B		
Exploring the Solar System: Craters^	ES, PS	Ph, Pr
Exploring the Solar System: Moonquakes	PS	Ph, Pr
Exploring the Solar System: Observe the Moon	PS	Ph
Exploring the Solar System: Story Blocks	PS	Pr, Pa
Exploring Science Practice Skills: Measure Up	A(F)	Ph, Pr, Pa

^Activities were duplicated from an earlier kit.

Appendix D: Instruments

Included in this appendix is a representative selection of the instruments used in the SEISE Project Professional Impacts Summative Evaluation. As this study was longitudinal, many of the same questions were used throughout, so the most recent surveys (2019 Baseline and 2020 APS) are presented here as illustrative examples. Also included is the 2020 COVID APS that was meant to understand some of the impacts of the pandemic on professionals connected with the SEISE project. The surveys varied in length, from about 15 to 30 minutes, and were administered online. Key terms were defined using rollover text, which have been included as footnotes in this appendix.

Also included in this appendix is the instrument for the first interview conducted as part of this study, which had questions focused on understanding professionals' survey responses and experiences with the SEISE project. Many of the interview questions included follow-up questions and discussion probes to help provide clarity when needed. The interview was conducted over the phone and took approximately one hour. The second interview was similar as it primarily asked follow-up questions related to professionals' first interview and APS responses. Interview information about professionals' experiences during the pandemic informed the 2020 COVID APS.

2019 Baseline Survey

1. In your current role at your institution, do you personally develop or implement exhibits or educational public programming?*

- ☐ Yes
- ☐ No

2. How many years of experience do you personally have engaging public audiences in learning about STEM[39] in informal education settings? This includes developing content. Please enter a numeric value only. _____

3. How many years of experience do you have personally engaging public audiences in Earth and space science[40] content in informal education settings? This includes developing content. Please enter a numeric value only. _____

5. In the past 12 months, have you personally engaged public audiences in Earth and space science content in an informal education setting? This includes developing content.

- ☐ Yes
- ☐ No

[39] STEM includes Science, Technology, Engineering, and Mathematics topics.

[40] For the purposes of this survey, "Earth and space science" is a STEM topic including astronomy, astrophysics, planetary science, Sun science (heliophysics), and Earth science (including climate change).

6. For each Earth and space content area below, please rate your level of agreement or disagreement with the statement: "I feel confident in my ability to facilitate learning experiences[41] with the general public in informal education settings about…"

	Completely disagree 1	2	3	4	5	6	7	8	9	Completely agree 10
Living with the Sun[42]										
The changing Earth[43]										
Our solar system and planets around other stars[44]										
Galaxies and beyond[45]										
Forces and energy of the universe[46]										
Connections between Earth and space research and our society[47]										

7. Please rate how often your institution presented each of the following Earth and space science topics in the past 12 months, considering ALL your institution's public engagement offerings (including programs, exhibits, media, online content, and any other relevant formats):

	Frequently – e.g. 1x/week	Occasionally – e.g. 1x/month	Rarely – e.g. 1x/year	Never	I don't know
Living with the Sun					
The changing Earth					
Our solar system and planets around other stars					
Galaxies and beyond					
Forces and energy of the universe					
Connections between Earth and space research and our society					

[41] E.g., presenting content on the floor of a museum to the general public

[42] E.g., energy from the sun, eclipses, shadows, solar flares

[43] E.g., climate change, plants and animals, ocean, atmosphere, geology

[44] E.g., orbits, icy moons, the search for life, exoplanets

[45] E.g., stars, birth of the universe, black holes, sizes and distances in space

[46] E.g., gravity, electromagnetic spectrum, magnetism

[47] E.g., our values influence Earth and space science questions, Earth and space research can inspire us and result in new technologies, studying Earth and space helps us make better decisions about our home in the universe, we address challenges in Earth and space.

8. Think about all the Earth and space science activities that your institution has used to engage with the public in the past 12 months. Overall, how often do you think visitors have the chance to demonstrate the following behaviors with your institution's Earth and space science activities? Each category below has a short list of example activities but there could be many more.

	Frequently – e.g. 1x/week	Occasionally – e.g. 1x/month	Rarely – e.g. 1x/year	Never	I don't know
Experience phenomena[48]					
Use the scientific and engineering process[49]					
Participate in the scientific community[50]					

9. In the past 12 months, did your institution use the following product types and engagement formats for Earth and space content? Please select all that apply.

	Yes	No	I don't know
Public programs [51]			
Exhibits and displays[52]			
Planetarium shows			
Media[53]			
Professional development[54]			

[48] E.g., use a gravity well, detect different wavelengths of light with a special camera, examine magnetic field models of a planet

[49] E.g., collect data from a light meter to graph the orbit of a model exoplanet around a star, use maps of global temperature over time to generate questions about climate change, try multiple designs of a rocket to hit a target in a launching experience)

[50] E.g., participate in training for a citizen science program to identify and count moon craters, take measurements of local weather conditions with a class and report them on a community website, work with groups of visitors to discuss how space science could impact their future

[51] Including hands-on activities, presentations, afterschool, camps, special events, and other facilitated experiences

[52] Not facilitated

[53] Video, print, digital, online

[54] For staff/volunteers, educators/teachers, scientists, students

10. In the past 12 months, did your institution have special programs or initiatives to reach any of the following audiences with Earth and space content? Examples could include outreach programs, special events, offerings in languages other than English, universal design of exhibits or programs, discounted admission for low-income visitors, etc.

	Yes	No	I don't know
Racial and ethnic minorities / communities of color			
American Indian / Alaska Native			
Girls			
Low-income / lower socioeconomic status			
Spanish-speaking audiences			
Non-native English speakers			
Disabled / differently abled communities			
Rural communities			
City communities			
At-risk youth			
Other communities			

11. As part of my Earth and space science education efforts, I feel confident in my ability to…

	Completely disagree 1	2	3	4	5	6	7	8	9	Completely agree 10
Engage young children.										
Engage diverse or underserved audiences.										
Engage audiences with societal content related to Earth and space science.										
Talk with visitors about difficult concepts such as common misconceptions.										
Partner with a community or informal learning organization.										
Partner with experts related to Earth and space science including scientist researchers, outreach professionals, and/or students.										
Partner with Earth and space science enthusiasts or amateur astronomy club members.										
Identify, use, and adapt non-NISE Net Earth and space resources.										

12. Do you personally use any of these NASA resources for Earth and space science content? You may write in any resources you use that are not listed here.

	Yes	No	I don't know
NASA newsletters			
NASA Museum Alliance			
HubbleSOURCE: ViewSpace			
Night Sky Network			
Solar System Ambassadors			
GLOBE (Global Learning and Observation to Benefit the Environment)			
NASA Space Place			
NASA.gov websites[55]			

13. Are you aware of the following resources?

	No, not aware	No, not aware but interested	Yes, aware	Yes, aware and interested	Yes, aware and have used
NISE Network monthly e-newsletter					
NISE Network's Earth & Space one-hour online workshops					
Nisenet.org					
Explore Science: Earth & Space training videos					
Digital toolkits (*Explore Science: Earth & Space*)					

14. In the past 12 months, how many collaborations with different community organizations has your institution had to engage the public in Earth and/or space science content?

Community partner organizations could include K-12 schools, community centers, libraries, afterschool programs, scout troops, etc. They might provide your site with audiences, volunteers, or a location to help conduct your programming.

- ☐ 0
- ☐ 1 to 2
- ☐ 3 to 5
- ☐ 6 to 10
- ☐ 11 to 20
- ☐ 21 to 40
- ☐ More than 40

[55] E.g., NASA Education Science WOW!, NASA Education Express

☐ I don't know

15. In the past 12 months, how many collaborations with different subject matter experts has your institution had to engage the public in Earth and/or space science content?

Subject matter experts include Earth and space science experts in fields such as heliophysics, Earth science, planetary science, and astrophysics. These individuals often help deliver the content and could include local scientists, Solar System Ambassadors, local student volunteers, retired professionals, people involved in astronomy clubs, and many more possibilities.

☐ 0
☐ 1 to 2
☐ 3 to 5
☐ 6 to 10
☐ 11 to 20
☐ 21 to 40
☐ More than 40
☐ I don't know

15a. In the past 12 months, how many subject matter experts from the different organization types listed below did your institution collaborate with around Earth and/or space science content? There are also write-in options below.[56]

	1 to 2	3 to 5	6 to 10	11 to 20	21 to 40	More than 40	None	I don't know
University or College – faculty, post-docs, staff, or students								
Industry								
Amateur astronomy group								
Government agency – local[57] or state[58]								
Government agency - federal[59]								
Write-in								

16. Are you planning any public events or programming around the Moon Landing 50th anniversary - Apollo 11?

☐ Yes
☐ No
☐ I don't know

[56] Logic was embedded in Question 15a, so that respondents would only see this if they indicated that they had any partnerships on Question 15.

[57] E.g., Parks Department

[58] E.g., Dept. of Environmental Protection

[59] E.g., NASA, NOAA

17. What contact with the Network was most important for encouraging you to apply for the 2019 toolkit?

- ☐ Information from a conference
- ☐ NISE Network Newsletter
- ☐ Hub-leader email
- ☐ Word of mouth from colleagues
- ☐ Professional listserv
- ☐ Social media posts (Facebook, LinkedIn, Twitter)
- ☐ Other - Write In:
- ☐ I don't know

17a. Please indicate at which conference(s) you interacted with NISE Network representatives? (check all that apply)[60]

- ☐ ASTC (Association of Science-Technology Centers)
- ☐ ACM (Association of Children's Museums)
- ☐ GLPA (Great Lakes Planetarium Association)
- ☐ SEPA (Southeastern Planetarium Association)
- ☐ Other - Write In:

18. Thank you for your time and providing your thoughts. Before you complete this survey, is there anything else you would like to add?

[60] Logic was embedded in Question 17a, so that respondents would only see this if they indicated that they got information from a conference on Question 17.

2019 Annual Partner Survey

1. How many years of experience do you personally have engaging public audiences in learning about STEM[61] in informal education settings? This includes developing content. Please enter a numeric value only. _____

2. How many years of experience do you have personally engaging public audiences in Earth and space science[62] content in informal education settings? This includes developing content. Please enter a numeric value only. _____

3. In the past 12 months, have you personally engaged public audiences in Earth and space science content in an informal education setting? This includes developing content.

- ☐ Yes
- ☐ No

4. For each Earth and space content area below, please rate your level of agreement or disagreement with the statement: "I feel confident in my ability to facilitate learning experiences[63] with the general public in informal education settings about..."

	Completely disagree 1	2	3	4	5	6	7	8	9	Completely agree 10
Living with the Sun[64]										
The changing Earth[65]										
Our solar system and planets around other stars[66]										
Galaxies and beyond[67]										
Forces and energy of the universe[68]										
Connections between Earth and space research and our society[69]										

[61] STEM includes Science, Technology, Engineering, and Mathematics topics.

[62] For the purposes of this survey, "Earth and space science" is a STEM topic including astronomy, astrophysics, planetary science, Sun science (heliophysics), and Earth science (including climate change).

[63] E.g., presenting content on the floor of a museum to the general public

[64] E.g., energy from the sun, eclipses, shadows, solar flares

[65] E.g., climate change, plants and animals, ocean, atmosphere, geology

[66] E.g., orbits, icy moons, the search for life, exoplanets

[67] E.g., stars, birth of the universe, black holes, sizes and distances in space

[68] E.g., gravity, electromagnetic spectrum, magnetism

[69] E.g., our values influence Earth and space science questions, Earth and space research can inspire us and result in new technologies, studying Earth and space helps us make better decisions about our home in the universe, we address challenges in Earth and space.

5. How much has NISE Net affected your confidence in facilitating learning experiences with the general public in informal education settings about…

	Not at all 1	2	3	4	5	6	7	8	9	A great deal 10
Living with the Sun										
The changing Earth										
Our solar system and planets around other stars										
Galaxies and beyond										
Forces and energy of the universe										
Connections between Earth and space research and our society										

6. Please rate how often your institution presented each of the following Earth and space science topics in the past 12 months, considering ALL your institution's public engagement offerings (including programs, exhibits, media, online content, and any other relevant formats):

	Frequently – e.g. 1x/week	Occasionally – e.g. 1x/month	Rarely – e.g. 1x/year	Never	I don't know
Living with the Sun					
The changing Earth					
Our solar system and planets around other stars					
Galaxies and beyond					
Forces and energy of the universe					
Connections between Earth and space research and our society					

6a. In the last 12 months, did your institution use NISE Net materials to cover the content area…[70]

	Yes	No	I don't know
Living with the Sun			
The changing Earth			
Our solar system and planets around other stars			
Galaxies and beyond			
Forces and energy of the universe			
Connections between Earth and space research and our society			

7. To what extent do you face barriers within your organization to sharing content about the changing Earth (climate change, plants and animals, ocean, atmosphere, and/or geology)?

- ☐ Not at all
- ☐ Very little
- ☐ Somewhat
- ☐ A great deal
- ☐ I don't know

8. To what extent do you face barriers within your community to sharing content about the changing Earth (climate change, plants and animals, ocean, atmosphere, and/or geology)?

- ☐ Not at all
- ☐ Very little
- ☐ Somewhat
- ☐ A great deal
- ☐ I don't know

9. What kinds of professional and/or public resources could the Network provide that would help you overcome these barriers and engage audiences in content related to the changing Earth (climate change, plants and animals, ocean, atmosphere, and/or geology)?

[70] Logic was embedded in Question 6a, so that respondents would only see this if they answered "Rarely," "Occasionally," or "Frequently" to the corresponding item on Question 6.

10. Think about all the Earth and space science activities that your institution has used to engage with the public in the past 12 months. Overall, how often do you think visitors have the chance to demonstrate the following behaviors with your institution's Earth and space science activities? Each category below has a short list of example activities but there could be many more.

	Frequently – e.g. 1x/week	Occasionally – e.g. 1x/month	Rarely – e.g. 1x/year	Never	I don't know
Experience phenomena[71]					
Use the scientific and engineering process[72]					
Participate in the scientific community[73]					

10a. In the last 12 months, did your institution use NISE Net materials during Earth and space science activities to engage visitors in engaging visitors in. . .[74]

	Yes	No	I don't know
Experiencing phenomenon related to Earth and space content?			
Using the scientific and engineering process related to Earth and space content			
Participating in the scientific community related to Earth and space content			

[71] E.g., use a gravity well, detect different wavelengths of light with a special camera, examine magnetic field models of a planet

[72] E.g., collect data from a light meter to graph the orbit of a model exoplanet around a star, use maps of global temperature over time to generate questions about climate change, try multiple designs of a rocket to hit a target in a launching experience)

[73] E.g., participate in training for a citizen science program to identify and count moon craters, take measurements of local weather conditions with a class and report them on a community website, work with groups of visitors to discuss how space science could impact their future

[74] Logic was embedded in Question 6a, so that respondents would only see this if they answered "Rarely," "Occasionally," or "Frequently" to the corresponding item on Question 6.

11. How much has NISE Net affected your institution's ability to engage the public in the following behaviors as a part of Earth and space activities?

	Not at all 1	2	3	4	5	6	7	8	9	A great deal 10	I don't know
Experience phenomena											
Use the scientific and engineering process											
Participate in the scientific community											

12. In the past 12 months, did your institution use the following product types and engagement formats for Earth and space content? Please select all that apply.

	Yes	No	I don't know
Public programs [75]			
Exhibits and displays[76]			
Planetarium shows			
Media[77]			
Professional development[78]			

12a. In the last year, did your institution use NISE Net products for [format] related to Earth and space content?[79]

	Yes	No	I don't know
Public programs			
Media			
Professional development			

[75] Including hands-on activities, presentations, afterschool, camps, special events, and other facilitated experiences

[76] Not facilitated

[77] Video, print, digital, online

[78] For staff/volunteers, educators/teachers, scientists, students

[79] Logic was embedded in Question 12a, so that respondents would only see this if they answered "Yes" to the corresponding item on Question 12.

13. In the past 12 months, approximately how many staff members and volunteers in your organization (including yourself, if applicable) implemented NISE Net Space and Earth Science Educational products with the public?

- ☐ None
- ☐ 1-5
- ☐ 6-10
- ☐ 11-20
- ☐ 21-40
- ☐ More than 40
- ☐ I don't know

14. Did your organization offer any information or provide educational programming about the solar eclipse, which occurred on August 21, 2017?[80]

- ☐ Yes
- ☐ No
- ☐ I don't know

14a. Did your organization offer any of the following related to the solar eclipse on August 21, 2017?

	Yes	No	I don't know
Educational programming prior to the August 2017 solar eclipse			
A solar eclipse event or related programming on August 21st, 2017			

14b. For any of your educational programming around the solar eclipse, did your organization utilize or promote any of the following?

	Yes	No	I don't know
NISE Net materials for planning			
NISE Net materials during the programming or event			
Citizen science opportunities (such as iNaturalist, GLOBE observer, etc.)			

[80] Question 14 was asked on the 2017 APS, and followed by a short survey asking for more details. Only the questions related to data in this report are included in this appendix.

15. Did your organization offer any information or provide educational programming about the Apollo 50th anniversary?

- ☐ No
- ☐ Yes
- ☐ I don't know

15a. For any of your educational programming around the Apollo 50th anniversary, did your organization utilize any of the following?[81]

	Yes	No	I don't know
NISE Net materials for planning			
NISE Net materials during the programming or event			

16. In the past 12 months, did your institution have special programs or initiatives to reach any of the following audiences with Earth and space content? Examples could include outreach programs, special events, offerings in languages other than English, universal design of exhibits or programs, discounted admission for low-income visitors, etc.

	Yes	No	I don't know
Racial and ethnic minorities / communities of color			
American Indian / Alaska Native			
Girls			
Low-income / lower socioeconomic status			
Spanish-speaking audiences			
Non-native English speakers			
Disabled / differently abled communities			
Rural communities			
City communities			
At-risk youth			
Other communities			

[81] Logic was embedded in Question 15a, so that respondents would only see this if they answered "Yes" to the corresponding item on Question 15.

16a. In the last year, did your institution use NISE Net materials to engage [audience] in Earth and space content?[82]

	Yes	No	I don't know
Racial and ethnic minorities / communities of color			
American Indian / Alaska Native			
Girls			
Low-income / lower socioeconomic status			
Spanish-speaking audiences			
Non-native English speakers			
Disabled / differently abled communities			
Rural communities			
City communities			
At-risk youth			
Other communities			

17. Please describe the other audiences you have engaged in Earth and science content:

18. How useful would it be for your organization to have access to professional development resources from the NISE Network related to engaging diverse or underserved audiences?

- ☐ Not at all useful
- ☐ Somewhat useful
- ☐ Very useful
- ☐ I don't know

19. How useful would it be for your organization to have access to public resources from the NISE Network related to engaging diverse or underserved audiences?

- ☐ Not at all useful
- ☐ Somewhat useful
- ☐ Very useful
- ☐ I don't know

20. What kinds of professional and/or public resources could the Network provide that would help you engage diverse and underserved audiences?

[82] Logic was embedded in Question 16a, so that respondents would only see this if they answered "Yes" to the corresponding item on Question 16.

21. Do you personally use any of these NASA resources for Earth and space science content? You may write in any resources you use that are not listed here.

	Yes	No	I don't know
NASA newsletters			
NASA Museum Alliance			
HubbleSOURCE: ViewSpace			
Night Sky Network			
Solar System Ambassadors			
GLOBE (Global Learning and Observation to Benefit the Environment)			
NASA Space Place			
NASA.gov websites[83]			

22. As part of my Earth and space science education efforts, I feel confident in my ability to…

	Completely disagree 1	2	3	4	5	6	7	8	9	Completely agree 10
Engage young children.										
Engage diverse or underserved audiences.										
Engage audiences with societal content related to Earth and space science.										
Talk with visitors about difficult concepts such as common misconceptions.										
Partner with a community or informal learning organization.										
Partner with experts related to Earth and space science including scientist researchers, outreach professionals, and/or students.										
Partner with Earth and space science enthusiasts or amateur astronomy club members.										
Identify, use, and adapt non-NISE Net Earth and space resources.										

[83] E.g., NASA Education Science WOW!, NASA Education Express

23. For your Earth and space science education efforts, how much has NISE Net affected your confidence in your ability to…

	Not at all 1	2	3	4	5	6	7	8	9	A great deal 10
Engage young children.										
Engage diverse or underserved audiences.										
Engage audiences with societal content related to Earth and space science.										
Talk with visitors about difficult concepts such as common misconceptions.										
Partner with a community or informal learning organization.										
Partner with experts related to Earth and space science including scientist researchers, outreach professionals, and/or students.										
Partner with Earth and space science enthusiasts or amateur astronomy club members.										
Identify, use, and adapt non-NISE Net Earth and space resources.										

24. In the last 12 months as part of your Earth and space science education efforts, did you use NISE Net resources[84] about any of these areas?

	Yes	No	Not applicable to my job
Engage young children.			
Engage diverse or underserved audiences.			
Engage audiences with societal content related to Earth and space science.			
Talk with visitors about difficult concepts such as common misconceptions.			
Partner with a community or informal learning organization.			
Partner with experts related to Earth and space science including scientist researchers, outreach professionals, and/or students.			
Partner with Earth and space science enthusiasts or amateur astronomy club members.			
Identify, use, and adapt non-NISE Net Earth and space resources.			

24a. Are you personally aware of NISE Net resources for. . . [85]

	Yes	No
Engage young children.		
Engage diverse or underserved audiences.		
Engage audiences with societal content related to Earth and space science.		
Talk with visitors about difficult concepts such as common misconceptions.		
Partner with a community or informal learning organization.		
Partner with experts related to Earth and space science including scientist researchers, outreach professionals, and/or students.		
Partner with Earth and space science enthusiasts or amateur astronomy club members.		
Identify, use, and adapt non-NISE Net Earth and space resources.		

[84] This could include kit materials, online resources, or online workshops.

[85] Logic was embedded in Question 24a, so that respondents would only see this if they answered "no" to the corresponding item on Question 24.

25. In the last 12 months, have you personally drawn on NISE Net resources to do any of the following with content areas other than Earth and space science?

	Yes	No	Not applicable to my job
Engage young children.			
Engage diverse or underserved audiences.			
Engage audiences with societal content related to Earth and space science.			
Talk with visitors about difficult concepts such as common misconceptions.			
Partner with a community or informal learning organization.			
Partner with experts related to Earth and space science including scientist researchers, outreach professionals, and/or students.			
Partner with Earth and space science enthusiasts or amateur astronomy club members.			
Identify, use, and adapt non-NISE Net Earth and space resources.			

26. In the past 12 months, how many collaborations with different community organizations has your institution had to engage the public in Earth and/or space science content?

Community partner organizations could include K-12 schools, community centers, libraries, afterschool programs, scout troops, etc. They might provide your site with audiences, volunteers, or a location to help conduct your programming.

- ☐ 0
- ☐ 1 to 2
- ☐ 3 to 5
- ☐ 6 to 10
- ☐ 11 to 20
- ☐ 21 to 40
- ☐ More than 40
- ☐ I don't know

27. In the past 12 months, how many collaborations with different subject matter experts has your institution had to engage the public in Earth and/or space science content?

Subject matter experts include Earth and space science experts in fields such as heliophysics, Earth science, planetary science, and astrophysics. These individuals often help deliver the content and could include local scientists, Solar System Ambassadors, local student volunteers, retired professionals, people involved in astronomy clubs, and many more possibilities.

- ☐ 0
- ☐ 1 to 2
- ☐ 3 to 5
- ☐ 6 to 10
- ☐ 11 to 20
- ☐ 21 to 40
- ☐ More than 40
- ☐ I don't know

27a. In the past 12 months, how many subject matter experts from the different organization types listed below did your institution collaborate with around Earth and/or space science content? There are also write-in options below.[86]

	1 to 2	3 to 5	6 to 10	11 to 20	21 to 40	More than 40	None	I don't know
University or College – faculty, post-docs, staff, or students								
Industry								
Amateur astronomy group								
Government agency – local[87] or state[88]								
Government agency - federal[89]								
Write-in								

[86] Logic was embedded in Question 27a, so that respondents would only see this if they indicated that they had any partnerships on Question 24.

[87] E.g., Parks Department

[88] E.g., Dept. of Environmental Protection

[89] E.g., NASA, NOAA

28. Please choose the response which best reflects your views on the NISE Network.

The NISE Network gives me the opportunity to…

	Completely disagree 1	2	3	4	5	6	7	8	9	Completely agree 10	Not applicable to my job
Receive new educational materials for engaging the public in Earth and space science.											
Meet professionals outside my organization.											
Learn from professionals outside my organization.											
Share with other professionals how I engage the public in Earth and space science.											
Foster local partnerships to engage the public in Earth and space science.											

28. Thinking beyond the NISE Network, how much do you value the following opportunities in general?

	Not at all 1	2	3	4	5	6	7	8	9	A great deal 10	Not applicable to my job
Receiving new educational materials for engaging the public.											
Meeting professionals outside my organization.											
Learning from professionals outside my organization.											
Sharing with other professionals how I engage the public.											
Fostering local partnerships to engage the public.											

29. Please rate your agreement with the following statements related to the Network.

	Completely disagree 1	2	3	4	5	6	7	8	9	Completely agree 10
I feel I am part of the NISE Network.										
I feel comfortable contributing to Network efforts.										
I feel comfortable reaching out to other partners in the Network with questions.										
I feel like the Network and regional hub leaders in the program make me feel welcome.										
I feel like my professional development needs are being addressed by Network activities.										
I feel like my institutional mission is being addressed by Network activities.										
Among the professional groups and networks I participate in, the NISE Network is especially valuable.										

30. Thank you for your time and providing your thoughts. Before you complete this survey, is there anything else you would like to add?

2019 Interview

General (Partner background)

On the sheet we sent you, we provided an overview of the different ways you may have interacted with the Earth & Space project such as using a toolkit, having the *Sun, Earth, Universe* Exhibition, or going to a professional development workshop or meeting.

So, to start, I'd like to ask about your current role in your institution.

1. What is your current job and how does Earth & space science fit in your current role?
    a. *Follow-up:* Is all of your work Earth & space-related or do you work on other topics as well?
    b. *Follow-up:* Have you always done this amount/type of Earth & space-related work or has that changed with your involvement with this project?
    c. *Follow-up:* How long have you been in this role and at this organization?
    d. *Follow-up:* Do you work with others in your institution on Earth & space?
        i. *Probe:* What are the roles/jobs of these other individuals?
        ii. *Probe:* How, if at all, do you work with these individuals on Earth & space?
    e. *Follow-up:* Overall, how regularly is your institution engaging the public in Earth & space science content?
        i. *Probe:* Is that amount different than before you became involved in the Explore Science: Earth and Space project?
2. How, if at all, have you been involved in other NISE Network (National Informal STEM Education Network) projects?
    a. *Follow up:* Have others in your institution been involved in other NISE Net projects?
        i. *Probe:* Other network project include Building with Bio, Explore Science: Let's do Chemistry, Frankenstein200, NanoDays, SustainABLE
    b. *Follow up:* What drew you to the Explore Science: Earth & Space project?
        i. *Probe:* Was it a personal contact/interaction with products/social media/conference?

Partnerships

We are interested in learning about how you may collaborate with others around Earth & space content. We define collaborations as: one-time or frequent, and they can include collaborators who present content directly to public audiences, engage staff and volunteers in professional development, or provide a location or site for outreach to occur and/or the audience who attends the event(s)

[If NO/IDK Partnerships on APS/BL]:

3. On the [APS/BL], you said that you have not been involved with/didn't know if you have had any [community and/or SME] partnerships that are Earth & space related. Is this still the case or have you since the fall/winter been involved with any partnerships around this topic, even in a small way? [If no – skip to #7, If yes, continue to #5 or #6]

[If Partnerships on APS/BL]:

4. On the Annual partner survey you mentioned that you have X collaborations with community organizations in the past year. Can you describe what the community partnership(s) you have had around Earth & space topics look like?
        i. *Probe:* How did this partnership start?
        ii. *Probe:* What does the work you do together entail? (i.e. how do you work together?)

iii. *Probe:* Is the work ongoing? Regularly recurring? One-time only? Is the partnership something that has ended?

b. *Follow up:* How have you used the SEISE materials as a part of this work? (i.e. products and/or partnerships PD materials)
   i. *Probe:* Did the Earth & space project influence this partnership in any other way? (i.e. help it start?/new connections?)

c. *Follow up:* Have there been any challenges or difficulties in your Earth & space community organization partnerships that the project could help with?

5. On the Annual partner survey you mentioned that you have X collaborations with subject matter experts in the past year. Can you describe what the subject matter expert(s) partnerships you have had around Earth & space topics look like?
   i. *Probe:* How did this partnership start?
   ii. *Probe:* What does the work you do together entail? (i.e. how do you work together?)
   iii. *Probe:* Is the work ongoing? Regularly recurring? One-time only? Is the partnership something that has ended?

   b. *Follow up:* Is the SME affiliated with NASA?
      i. *Probe:* Clarify what their affiliation is, even if not NASA

   c. *Follow up:* How have you used the Explore Science: Earth and Space project materials as a part of this work? (i.e. products and/or partnerships PD materials)
      i. *Probe:* Did the Earth & space project influence this partnership in any other way? (i.e. help it start?/new connections?)

   d. *Follow up:* Have there been any challenges or difficulties in your Earth & space SME partnerships that the project could help with?

[For people w/no partnerships]:

6. Ok, so today and on the [APS/BL], you mentioned that you have did not have any collaborations with [community organizations / subject matter experts] in the past year. Have you considered partnering with another community organization or subject matter expert to deliver Earth & space science to the public?
   a. *Follow up:* Can you describe any particular reasons or barriers that keep you from partnering with others around Earth & space content?
   b. *Follow up:* Is there something about the Explore Science: Earth and Space resources that does not encourage or support partnerships at your institution? Please explain.
   c. [if they mention a failed partnership] What made that partnership unsuccessful?
7. How, if at all, could the Explore Science: Earth and Space project help you facilitate potential partnerships? (I.e. Resources, PD, contacts?)

[For everyone] Thinking broadly about collaborating with other organizations.

8. [If high confidence]: On the survey you said you had fairly high confidence around partnering. What Explore Science: Earth and Space products, if any, have been particularly helpful for supporting your confidence in partnering?
   a. *Follow up:* Do you feel like you would need more help from the project around strengthening partnerships? If yes, please explain which areas.
9. [If low confidence]: On the survey, you said you had fairly low confidence around building partnerships. What could the Explore Science: Earth and Space project offer to help you in partnering with community organizations? With subject matter experts?
   i. *Probe:* Are you aware of any of the Explore Science: Earth and Space project resources related to partnerships?
10. In your education programs that are not E&s-related, does your institution typically partner with outside organizations?

a. *Follow up:* [If have Earth & space partnerships]: How, if at all, are these partnerships different from the ones you have around Earth & space science?
b. *Follow up:* [If don't have Earth & space partnerships]: Is there something about these topics, as opposed to Earth & space science, that encourages these partnerships at your institution? Please explain.

11. Do you know about any local STEM learning ecosystems in your area? Reminder for all: STEM learning ecosystems can be thought of as local, regional, or state networks that include different members of schools, businesses, informal education, all working together around STEM.
    a. *Follow up:* Are you familiar with this term?
    b. *Follow up:* How, if at all, have you been a part of a STEM learning ecosystem?
    c. *Follow up:* Would you be interested in this type of opportunity? Why/why not?

Products use/PD experiences

We are interested in hearing about your use of various Explore Science toolkit activities.

12. To start, we know your institution has 3 physical kits from the Network, but have you ever used the digital resources?
    i. *Probe:* How have you been using them? How did you find out about them? How, if at all, do other staff use these activities? How do they find out about these activities?

We want to transition to talk about the physical activities.

13. Which activities from the physical toolkits do you tend to use from the kit? Why?
    a. *Follow up:* How do you use these materials?
        i. *Probe:* Was it for an event? Do you combine them with other non-Explore Science activities or exhibits at your organization? Are they easy to use?
    b. *Follow up:* What audiences do you use these materials with and why?
    c. *Follow up:* Would you say these activities are relevant to your museum?
        i. *Probe:* i.e. Do they slot in easily with the types of programs that you already do? Do other staff use them?
        ii. *Probe:* How do they find out about these activities?
    d. *Follow up:* How, if at all, has using these activities contributed to your confidence in Earth & space science content?
    e. *Follow up:* [If mentions increase]: How, if at all, has having increased confidence in this area helped you engage visitors in this content?
14. Which activities from the physical toolkits do you tend to not use or avoid? Why?
    i. *Probes:* Are they difficult to use? Hard to train others? Don't meet your educational philosophy or your institution's goals? Considered not high quality? Not good for your audiences(s)? Etc.
15. [If not already mentioned]: Did you use any Explore Science: Earth and Space project resources to do programming for the solar eclipse in 2017?
    i. *Probe:* What did the programming entail? What audiences were involved or targeted? How, if at all, were these resources helpful?
16. [If not already mentioned]: Did you use any Explore Science: Earth and Space project resources to do programming for the Apollo 50 anniversary?
    i. *Probe:* What did the programming entail? What audiences were involved or targeted? How, if at all, were these resources helpful?
17. How have you modified or adapted any of the materials and why?
18. [If they have the SEU exhibit] Can you talk about how having the *Sun, Earth, Universe* exhibit has impacted your work or that of your organization?

i. *Probes:* Has it been connected with activities/events? Brought in new audiences/supported partnerships?

19. [If needed]: Beyond the kit activities, what other Explore Science: Earth and Space products, if any, help support your efforts to engage the public in Earth and space content? (i.e. PD products such as training videos, guides)
    a. *Follow up:* What specific parts of the videos/guides/other activities were helpful to your work?
20. Have you attended or watched recordings of online workshops?
    i. *Probe:* Were they live or were they the archived recordings?
    ii. *Probe:* How have they been helpful to your work?
    iii. *Probe:* What specific components or content covered in the workshops has been helpful?
21. Thinking about your use of different products and/or your engagement with the PD, has your involvement been consistent since you got involved with the Earth & Space project?
    i. *Probe:* How, if at all, has it changed over the last [few] years? What were the reasons for that change?
    ii. *Probe:* [If it stayed the same], do you think it will change over the next year?

SMD Content areas

Now we are going to talk about Earth & space related content.

22. How would you describe your understanding of Earth & space topics before being involved in the Explore Science project?
23. How would you describe your understanding of Earth & space science today?
    a. *Follow-up:* How, if at all, has involvement in the Explore Science project affected your current understanding of E&s science?
    b. *Follow-up* if they indicate they have increased understanding: What Explore Science: Earth and Space resources or professional development offering has been the most useful for your learning about E&s concepts?
        i. *Probe:* How has that helped you understand Earth & space concepts?

We are now going to refer to some of your responses on the survey to help us better understand what you meant.

24. [If there is one content area that was rated noticeably lower than others:] You responded with fairly high confidence in all the areas, but rated "XXX" as the lowest. How, if at all has the Explore Science: Earth and Space project helped your confidence in this particular area?
    a. *Follow up:* Do you usually cover this topic at your institution?
        i. Probe if not: Are there any reasons why this topic is difficult to cover at your institution? Please explain.
    b. *Follow up:* [If mentions increase]: How, if at all, has having increased confidence in this area helped you engage visitors in this content?
    c. *Follow up:* How could the project provide information related to this topic that would help you with your work in this area?
25. [If all content areas were rated about the same but are LOW]: You responded with fairly low confidence in all the areas. How, if at all, has the Explore Science: Earth and Space project helped your confidence in any of these?
    a. *Follow up:* Do you usually cover these topics at your institution?
        i. *Probe if not:* Are any of these topics difficult to cover at your institution? Why?
    b. *Follow up:* [If mentions increase]: How, if at all, has having increased confidence helped you engage visitors in this content area?

c. *Follow up:* How could the project provide information related to any of these topics that would help you with your work?

26. [If all content areas were rated about the same but are HIGH]: You responded with fairly high confidence in all the content areas. How, if at all, has the Explore Science: Earth and Space project helped your confidence in any of these?
    a. *Follow up:* Do you usually cover these topics at your institution?
        i. *Probe if not:* Are any of these topics ones that are difficult to cover at your institution? Why?
    b. *Follow up:* [If mentions increase]: How, if at all, has having increased confidence in this area helped you engage visitors in this content?
    c. *Follow up:* How could the project provide information related to these topics that would help you with your work?

We want to ask a few more questions related to these specific Earth & space topics just to help us understand a little more about what you are mentioning….

27. [Pick one area that they have been mentioning above]: Which Explore Science: Earth and Space activities, if any, do you think relate to [this content?]
    a. List of options to pick from (related to area discussed above):
        i. Living with the Sun?
        ii. The changing Earth?
        iii. Our solar system and planets around other stars?
        iv. Galaxies and beyond?
        v. Forces and energy of the universe?
        vi. Connections between Earth and space research and our society?
    b. *Follow up:* How would you define this content area for visitors?
28. [Pick one additional area to ask these questions about]: Which Explore Science: Earth and Space activities, if any, do you think relate to [this content?]
    a. List of options to pick from (1 will be identified per individual)
        i. Living with the Sun?
        ii. The changing Earth?
        iii. Our solar system and planets around other stars?
        iv. Galaxies and beyond?
        v. Forces and energy of the universe?
        vi. Connections between Earth and space research and our society?
    b. *Follow up:* How would you define this content area for visitors?

3Ps

We are going to ask about some behaviors that you indicated visitors [did/did] not have a chance to demonstrate with your institution's Earth & space activities.

If they don't offer one of the 3Ps: (ask once and up to twice for different 3P categories, if applicable)

29. [If applicable]: You said that your visitors do not have the chance to ["Experience phenomena" / "Use the scientific and engineering process" / " Participate in the scientific community"] with your institution's Earth & space activities. Does your institution offer opportunities to do this in general outside of Earth & space content?
        i. *Probe:* If no, what are the barriers?
        ii. *Probe:* Did you know that the Explore Science: Earth and Space project has materials that can be used in this way?
30. [If applicable]: You said that your visitors do not have the chance to ["Experience phenomena" / "Use the scientific and engineering process" / " Participate in the scientific community"] with your institution's Earth & space activities. Does your institution offer opportunities to do this in general outside of Earth & space content?

i. *Probe:* If no, what are the barriers?
ii. *Probe:* Did you know that the Explore Science: Earth and Space project has materials that can be used in this way?

If they do offer one of the 3Ps (ask once and up to twice for different 3P categories, if applicable. If asking about participate—there is an additional question)

31. [IF ASKING ABOUT PARTICIPATE IN NEXT QUESTION]: What do you expect visitors to be able to do when you hear "Participate in the scientific community"?
32. Pick one: You said that your visitors [rarely/occasionally/frequently] have the chance to ["Experience phenomena" / "Use the scientific and engineering process" / "Participate in the scientific community"] with your institution's Earth & space activities. Can you describe an example of visitors being able to do this?
    i. *Probe:* How, if at all, do you use the Explore Science: Earth and Space project materials to engage visitors in these behaviors? Have these materials been helpful?
    ii. *Probe:* If not using Explore Science materials, did you know that the Explore Science: Earth and Space project has materials that can be used in this way?
33. Pick one: You said that your visitors [rarely/occasionally/frequently] have the chance to ["Experience phenomena" / "Use the scientific and engineering process" / "Participate in the scientific community"] with your institution's Earth & space activities. Can you describe an example of doing this?
    i. *Probe:* How, if at all, do you use the Explore Science: Earth and Space materials to engage visitors in these behaviors? Have these materials been helpful?
    ii. *Probe:* If not using Explore Science materials, did you know that the Explore Science: Earth and Space has materials that can be used in this way?

Practices

There are also several practices that the Explore Science: Earth and Space project has focused on. We asked you about these on our Annual Partner Survey and whether you implemented these as a part of your Earth & space-related work. We have a few additional questions.

34. Prior to participating in the Explore Science: Earth and Space project, were you "Engaging audiences with societal content related to Earth and space science"?
    a. *Follow up:* Can you give an example of how the Explore Science: Earth and Space project may have affected your work in this area?
        i. *Probe:* Which products or information do you feel helped you with this practice?
35. Is there anything else the project could offer that would help you integrate this practice ["Engaging audiences with societal content related to Earth and space science"] into your work?
    a. *Follow up:* Is there anything at your institution that stands in the way of doing this practice?
36. Prior to participating in the Explore Science: Earth and Space project, were you "Talking with visitors about difficult concepts such as common misconceptions"?
    a. *Follow up:* Can you give an example of how the Explore Science: Earth and Space project may have affected your work in this area?
        i. *Probe:* Which products or information do you feel helped you with this practice?

37. Is there anything else the project could offer that would help you integrate this practice ["Talking with visitors about difficult concepts such as common misconceptions"?] into your work?
    a. *Follow up:* Is there anything at your institution that stands in the way of doing this practice?
38. For any of the practices we haven't discussed, is there any resource (product or person) that the Explore Science: Earth and Space project [or Network resource—if knowledgeable?] has offered that has changed the way you're doing that work at your institution?
39. How, if at all, do you personally engage diverse or underserved audiences in Earth & space?
    a. *Follow up:* How, if at all, does your organization support this work? (i.e. what does the organization collectively do in this area)
    b. *Follow up:* What other support or resources from the Explore Science: Earth and Space project would be helpful for this work?

Additional Resources and Community

We just have a few more questions before we are done.

40. [Only if not mentioned previously and we know they went to the Network Partner Meeting]: How, if at all, did the partner meeting affect any of your work around Earth and space?
41. Please explain how, if at all, being part of this project has helped you feel more connected to other NASA projects or resources.
    a. *Follow up:* Has your use of NASA resources changed in any way due to the Explore Science: Earth and Space project?
    b. *Follow up*—if they haven't provided one previously: Can you provide an example of how you are using NASA resources?
42. Other than new educational materials for the public, what else do you value about the Explore Science: Earth and Space project?
        i. *Probes:* Personally/professionally/organizationally
43. In your involvement with the Earth & space project, do you feel like you are a part of the larger NISE Net community of professionals engaging the public in Earth & space science?
    a. *Follow up* [if yes]: How would you describe this community?
        i. *Probe:* How would you describe your role in this community?
    b. *Follow up:* What else do you want from this community? (I.e. suggestions for improvement?)
44. Thank you so much! Of everything we've discussed today, do you have any further questions or is there anything else you'd like to add?

2020 COVID Annual Partner Survey

1. What is the current status of your facility being open to the public for in-person experiences? (i.e. general admission, camps, school-related opportunities, etc.)

- ☐ Our facility was temporarily closed to the public but is now open with reduced visitor capacity
- ☐ Our facility was temporarily closed to the public but is now open without changes to visitor capacity
- ☐ Our facility never closed to the public
- ☐ Our facility is currently closed to the public
- ☐ Other (please describe):_____

2. Thinking about your staffing levels right now, how has your staffing level changed since March 2020?

- ☐ It's decreased (i.e. through layoffs, furloughs etc.)
- ☐ It's about the same (i.e. roughly the same number of staff)
- ☐ It's increased (i.e. new positions created and filled, resulting in expanded staffing numbers)

3. Between March 2020 and October 2020, how would you describe your organization's Earth and space virtual programming as compared to prior to the pandemic?[90]

We are considering virtual programming to be anything that was done online or through remote public engagement either through live streaming or pre-recorded virtual offerings.

	Never	Less than before	About the same	More than before	Completely new	I don't know
Online programming with educators (i.e. hands-on activities, demos, presentations, story time, etc.)						
Online interviews with subject matter experts / scientists						
Support for virtual pre-K to 12 school efforts						
Virtual support to afterschool or out out-of-school programs						
Virtual events (i.e. star party, Earth Day, etc.)						
Virtual camps offered through the institution						
Virtual tours						
Virtual website activities (i.e. online exhibits, online videos, online activities and games, etc.)						
Sharing content on social media (articles, information, links, etc.)						
Broadcast media interviews or programs (i.e. television, radio, etc.)						

4. Please describe any other types of virtual offerings you have done for Earth and space since March 2020.

[90] Responses were "We never offer this, either in the past or now," "We used to do this and are doing this less than before," "We used to do this and are doing this about the same as before," "We used to do this and are doing this more than before," "This is a completely new offering for use," and "I don't know."

5. Did your institution use NISE Network materials[91] when offering the following virtual offerings between March and October 2020?

	Yes	No	I don't know
Online programming with educators (i.e. hands-on activities, demos, presentations, story time, etc.)			
Online interviews with subject matter experts / scientists			
Support for virtual pre-K to 12 school efforts			
Virtual support to afterschool or out out-of-school programs			
Virtual events (i.e. star party, Earth Day, etc.)			
Virtual camps offered through the institution			
Virtual tours			
Virtual website activities (i.e. online exhibits, online videos, online activities and games, etc.)			
Sharing content on social media (articles, information, links, etc.)			
Broadcast media interviews or programs (i.e. television, radio, etc.)			

6. Please describe how you may have modified or adapted NISE Network materials for your virtual Earth and space programming since March 2020.[92]

7. Do you anticipate that these types of virtual offerings will continue for the remainder of the pandemic?

	Yes	No	I don't know
Online programming with educators (i.e. hands-on activities, demos, presentations, story time, etc.)			
Online interviews with subject matter experts / scientists			
Support for virtual pre-K to 12 school efforts			
Virtual support to afterschool or out out-of-school programs			
Virtual events (i.e. star party, Earth Day, etc.)			
Virtual camps offered through the institution			
Virtual tours			
Virtual website activities (i.e. online exhibits, online videos, online activities and games, etc.)			
Sharing content on social media (articles, information, links, etc.)			
Broadcast media interviews or programs (i.e. television, radio, etc.)			

[91] This could include any NISE Network activities, toolkits, digital materials, videos, or online resources

[92] Logic was embedded in Question 6, so that respondents would only see this if they answered "yes" to the any item on Question 5.

8. Between March 2020 and October 2020, how would you describe your organization's in-person Earth and space programming as compared to prior to the pandemic?[93]

	Never	Less than before	About the same	More than before	Completely new	I don't know
Unfacilitated in-person experiences (i.e. exhibits and displays)						
In-person group experiences with educators (i.e. camps, special events, tours)						
In-person programming with educators (i.e. hands-on activities, demos, presentations, story time, etc.)						
In-person interviews with subject matter experts / scientists						
Providing physical materials that can be used at home (e.g. take-home activities, take-home kits, pick-up kits, etc.)						
In-person support to schools (i.e. field trips, curriculum, classroom kits, etc.)						
In-person support to afterschool or out out-of-school programs						
In-person events (i.e. star party, Earth Day, etc.)						
Planetarium shows						

9. Please describe any other types of in-person offerings you have done for Earth and space since March 2020.

[93] Responses were "We never offer this, either in the past or now," "We used to do this and are doing this less than before," "We used to do this and are doing this about the same as before," "We used to do this and are doing this more than before," "This is a completely new offering for use," and "I don't know."

10. Did your institution use NISE Network materials when offering the following in-person offerings between March and October 2020?

	Yes	No	I don't know
Unfacilitated in-person experiences (i.e. exhibits and displays)			
In-person group experiences with educators (i.e. camps, special events, tours)			
In-person programming with educators (i.e. hands-on activities, demos, presentations, story time, etc.)			
In-person interviews with subject matter experts / scientists			
Providing physical materials that can be used at home (e.g. take-home activities, take-home kits, pick-up kits, etc.)			
In-person support to schools (i.e. field trips, curriculum, classroom kits, etc.)			
In-person support to afterschool or out out-of-school programs			
In-person events (i.e. star party, Earth Day, etc.)			
Planetarium shows			

11. Please describe how you may have modified or adapted NISE Network materials for your in-person Earth and space programming since March 2020.

12. Do you anticipate that these types of in-person offerings will continue for the remainder of the pandemic?

	Yes	No	I don't know
Unfacilitated in-person experiences (i.e. exhibits and displays)			
In-person group experiences with educators (i.e. camps, special events, tours)			
In-person programming with educators (i.e. hands-on activities, demos, presentations, story time, etc.)			
In-person interviews with subject matter experts / scientists			
Providing physical materials that can be used at home (e.g. take-home activities, take-home kits, pick-up kits, etc.)			
In-person support to schools (i.e. field trips, curriculum, classroom kits, etc.)			
In-person support to afterschool or out out-of-school programs			
In-person events (i.e. star party, Earth Day, etc.)			
Planetarium shows			

13. How, if at all, have you connected with the Network since March 2020? [check all that apply]

- ☐ Attended a NISE Network professional development online workshop
- ☐ Read NISE Network newsletters
- ☐ Read NISE Network blog posts (COVID-19 resources, racial justice, partner highlights, etc.)
- ☐ Been in contact with Network and regional hub leaders
- ☐ Been in contact with other partners in the Network
- ☐ Connected with another NISE Network project (i.e. Sustainability in Science and Technology Museums or accessed resources from previous Network projects such as the NanoDays or Let's Do Chemistry kits)
- ☐ Connected with the NISE Network on a social networking platform (Facebook, Twitter, LinkedIn, Pinterest, Instagram)
- ☐ I have not connected with the Network
- ☐ Other: _____

14. How, if at all, did connecting with the NISE Network during this time impact your feelings about the Network?[94]

15. Please rate your agreement with the following statements related to the Network, for prior to March 2020

	Strongly disagree	Disagree	Agree	Strongly agree
I feel I am part of the NISE Network.				
I feel comfortable contributing to Network efforts.				
I feel comfortable reaching out to other partners in the Network with questions.				
I feel like the Network and regional hub leaders in the program make me feel welcome.				
I feel like my professional development needs are being addressed by Network activities.				
I feel like my institutional mission is being addressed by Network activities.				
Among the professional groups and networks I participate in, the NISE Network is especially valuable.				

[94] Logic was embedded in Question 14, so that respondents would only see this if they checked at least one way they connected with the Network on Question 13.

16. Please rate your agreement with the following statements related to the Network, for after March 2020

	Strongly disagree	Disagree	Agree	Strongly agree
I feel I am part of the NISE Network.				
I feel comfortable contributing to Network efforts.				
I feel comfortable reaching out to other partners in the Network with questions.				
I feel like the Network and regional hub leaders in the program make me feel welcome.				
I feel like my professional development needs are being addressed by Network activities.				
I feel like my institutional mission is being addressed by Network activities.				
Among the professional groups and networks I participate in, the NISE Network is especially valuable.				

17. How could the NISE Network support you and your institution during this time?

18. Do you have anything else to add?

Appendix E: Respondent Description

Professionals who participated in the SEISE Project Professional Impacts Summative Evaluation interacted with the project in many different ways and represented a variety of institutions. As described in Section 2.1: Data collection, survey participants were recruited from the NISE Network Quickbase database. In addition to supporting recruitment, the database recorded information about how professionals had interacted with the project, such as what resources their institution received or what professional development opportunities they had attended. This appendix provides an overview of the professionals who were included in the four groups of data analyzed (longitudinal, 2019 APS, 2020 APS, and interviews) for this study.

SEISE project involvement

Over the course of the SEISE project, four toolkits of hands-on activities were awarded to partner institutions. In 2017 and 2018, 250 kits were awarded each year; this number was increased to 350 kits for both 2019 and 2020. Table B1 shows the percentages of professionals whose organizations received toolkits for the different data sets referred to in this report. As can be seen, most professionals who participated in the study had at least one toolkit at their institution. Professionals without toolkits were much less likely to participate in the study, even though approximately half of the professionals contacted through survey recruitment were at organizations without toolkits.

Table B1. Percentage of professionals at institutions with Explore Science: Earth and Space toolkits, by number awarded

	Longitudinal (N=178)	2019 APS (N=256)	2020 APS (N=195)	Interview[95] (N=13)
No kits	3%	10%	6%	0%
One kit	36%	26%	14%	15%
Two kits	28%	21%	21%	38%
Three kits	34%	43%	22%	46%
Four kits[96]	--	--	38%	--

In 2019, 52 copies of the *Sun, Earth, Universe* exhibition were distributed to partners across the country. Some partners' awardee agreements involved sharing this exhibition with other institutions, thus, the total exhibition reach will ultimately include over 100 institutions. For the different data sets included in this report, Table B2 represents the percentage of professionals at institutions who either had been awarded the exhibition or had been the recipient of a shared exhibition. Most study participants did not have the exhibition at their institution, which is unsurprising considering the number of copies produced. However, the percentage of professionals participating in the study who were at institutions that did have the exhibition reflected a relatively higher proportion of professionals than was the case for the Network as a whole. While approximately 12% of the professionals contacted through survey recruitment

[95] Due to the shipping time and impacts of COVID-19, the number of kits for interviewees was taken from what they had at the time of their first interview.

[96] The fourth kit was distributed at the beginning of 2020, after the 2019 APS and longitudinal data were collected.

were at an organization that had hosted the exhibition, 16-23% of study participants were at institutions with the exhibition.

Table B2. Percentage of professionals at institutions with the Sun, Earth, Universe exhibition

	Longitudinal (N=178)	2019 APS (N=256)	2020 APS (N=195)	Interview (N=13)
Has exhibition	16%	23%	19%	15%
Does not have exhibition	84%	77%	81%	85%

Over the last few years, the NISE Network has hosted 43 online workshops connected with the SEISE project. Registration for the workshops is tracked and recorded through the NISE Network Quickbase database, and registrants are forwarded the recorded session after it has taken place. These recording are also available on the NISE Network website for anyone to view. Table B3 below shows the range of involvement professionals had with online workshops. The number of workshops attended by an individual does not take into account any workshop they may have viewed after the recording was posted on the NISE Net website. Registration records show that most professionals register and intend to go to at least a few live online workshops, with some planning to attend more. The highest number of workshops that any individual in the sample registered for was 21.

Table B3. Percentage of professionals who registered for online workshops

	Longitudinal (N=178)	2019 APS (N=256)	2020 APS (N=195)	Interview (N=13)
None	36%	48%	45%	46%
1 to 3	42%	38%	38%	23%
4 to 7	11%	7%	9%	8%
8 or more	11%	7%	7%	23%

A few of the other opportunities offered by the NISE Network that may have influenced professionals' experiences with SEISE included participating in the 2017 4-Week Online Workshop or attending the 2019 Earth & Space Project Partner Meeting. Table B4 shows professionals' participation in these opportunities. In addition, many professionals involved in the SEISE Project Professional Impacts Summative Evaluation study were also involved in the Nano NISE Network, with over 70% of each analyzed survey group (longitudinal, 2019 APS, and 2020 APS) and just under half of the interviewees being active in the Nano project.

Table B4. Percentage of professionals who participated in other SEISE project professional development offerings besides the online workshops

	Longitudinal (N=178)	2019 APS (N=256)	2020 APS (N=195)	Interview (N=13)
4-Week Online Workshop	15%	6%	5%	15%
2019 Partner Meeting	45%	33%	26%	54%

Institutional description

The SEISE project awarded materials to and reached a variety of museums and other informal STEM education institutions, which represented a range of sizes (defined by either annual attendance or budget) and locations (e.g. rural, small city, large city, etc.). In addition, this study included professionals from the diversity of partner institutions involved in the SEISE project. Overall, the four groups of data analyzed (longitudinal, 2019 APS, 2020 APS, and interviews) for this study had roughly the same proportional representation of different organization types. Most study participants were from informal science education organizations, such as museums and science centers, with fewer than 10% belonging to other organization types (e.g. industry, college or university, government organizations). Many of these ISE organizations were museums, which are classified in the NISE Network Quickbase database under a variety of overlapping museum types. In particular, 33-39% of professionals who responded to one of the surveys worked at an organization with a planetarium, 45-51% worked at a children's museum, and 54-59% worked at a science or technology museum. Overall, participants in the interview sample have the same or higher proportional representation for each of these museum types (children's: 46%, planetarium: 62%, and science or tech: 77%).