SciAct STEM Ecosystems Summative Evaluation

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Image: What Values Do You Share? conversation starter activity at the 2025 STEM Learning Ecosystems and Community Partnership Meeting in Saint Paul, MN. Image credit: Emily Maletz for NISE Network.

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We want to thank the many professionals who took time to answer surveys about their experiences in this project. Their contributions were vital for understanding the impacts of the SciAct STEM Ecosystems project.

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BACKGROUND

What are STEM learning ecosystems?

STEM learning ecosystems are intentionally designed, **community-wide partnerships that enable people to actively participate in STEM throughout their lives**. Place-based learning ecosystems are responsive to their local context and draw on expertise and resources across a community to create experiences that are relevant to local learners.

Partners in a STEM learning ecosystem can include:

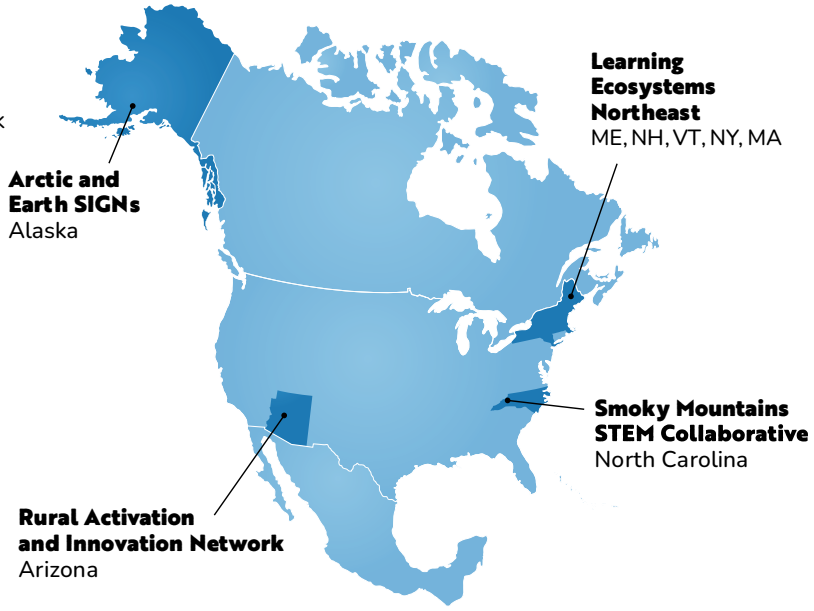
The SciAct STEM Ecosystems team includes: Center for Innovation in Informal STEM Learning at Arizona State University; Arctic and Earth SIGNs led by the University of Alaska Fairbanks; Rural Activation and Innovation Network, currently led by Arizona Science Center; Smoky Mountains STEM Collaborative led by Southwestern Community College; Learning Ecosystems Northeast led by Gulf of Maine Research Institute; the National Informal STEM Education Network; and the Museum of Science, Boston.

Image sources: Futuremundo and Swift Creek Media

Inquiry study

We used a STEM learning ecosystem framework to study **four projects** that are a part of NASA's Science Activation (SciAct) program.

We wanted to understand what principles and practices collaborations use to: support strong relationships across varied partners; create locally relevant opportunities to learn about Earth and space science; and promote belonging in STEM.



Key ideas learned through our inquiry study

COMMUNITY

STEM learning ecosystems are built and sustained through intentional practices; thrive through reciprocal relationships; and are grounded in their geographic and cultural context.

BELONGING

Ecosystems can broaden participation by cultivating genuine relationships among individuals and organizations; creating a flexible and transparent culture; sharing programming and resources; and prioritizing a sense of belonging. Belonging refers to the feeling of being connected to a community, place, or situation, and being supported and welcomed there.

ENGAGEMENT

Authentic STEM engagement starts with understanding what is relevant to learners and communities, then creates connections to content through active learning experiences.

Relevance

Connects to identity and cultures, promotes a sense of belonging, and fosters inclusion.

STEM content

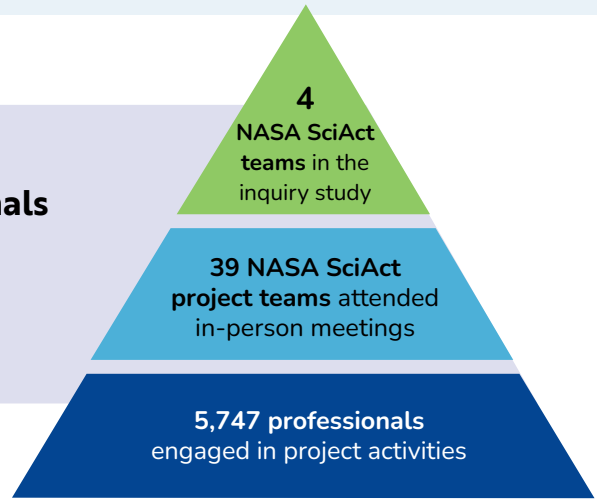
Includes community observations, scientific data, assets, and a range of expert perspectives.

Experience Design

Supports active learning, encourages dialogue, and builds on community strengths.

Learnings from our inquiry study were shared with STEM engagement professionals

Principles and practices related to the key ideas were shared with **NASA SciAct project teams** and **STEM engagement professionals** through various channels.



PROJECT REACH

SUMMATIVE EVALUATION

What we studied

We focused on learning how attendees' participation in the webinars and in-person meetings impacted their:

1. **Understanding of the key ideas**
2. **Intent to use what they learned**
3. **Connections with others**

DATA COLLECTION METHODS

Data were collected using embedded evaluation activities, such as chat prompts during webinars, or through digital surveys emailed to attendees after the meetings.

Project Activities

IN-PERSON MEETINGS

The project team hosted two in-person meetings: one in Tempe, AZ (2024) and one in Saint Paul, MN (2025), with attendees representing many NASA SciAct project teams and their partners. Each meeting included plenary sessions with icebreaker activities, concurrent sessions, a resource showcase, networking opportunities, and shared meals.

WEBINARS

The project team hosted webinars that shared project findings and resources and made connections to related work:

- One webinar was held specifically for the NASA SciAct community.
- A series of webinars were shared with the broader STEM engagement community through National Informal STEM Education (NISE) Network's online workshop series.

ADDITIONAL RESOURCES

The project team produced resources to share learnings and support engagement with the key ideas during webinars and in-person meetings. These included conversation starters and activities to spark reflection and discussion.

Explore the resources at:
https://www.nisenet.org/stem-learning-ecosystems

Evaluation findings overview

The SciAct STEM Ecosystem project supported sharing and learning across the Science Activation portfolio and leveraged external partners to expand the reach to the national STEM engagement community, contributing to the achievement of NASA SciAct Mid-Level Objectives 4a and 4b.

IN-PERSON MEETINGS

Offered opportunities for deeper learning and connections among NASA SciAct teams and NISE Network partners

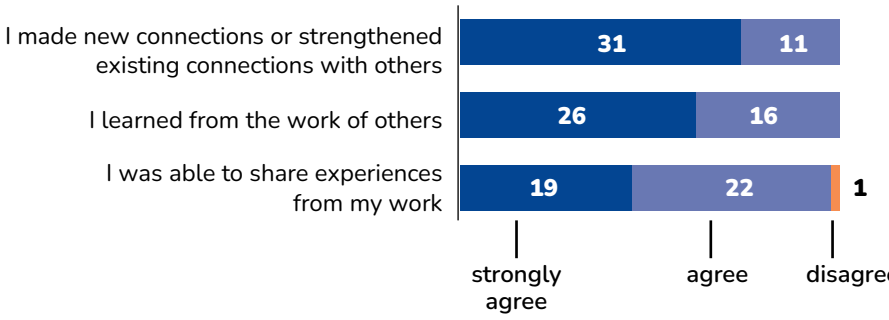
WEBINARS

Provided wide access, attracting a variety of STEM engagement professionals

Connection and collaborative learning

In-person meetings offered opportunities for colleagues to develop relationships and learn from and with each other.

"Through participation in the NASA SciAct STEM Learning Ecosystems and Community Partnership Meeting..."*
(n=42)



**strongly disagree was not selected*

> *"The plenaries and icebreaker activities, along with the various session formats and meeting activities, contributed to collaborative learning."*
>
> –IN-PERSON MEETING ATTENDEE

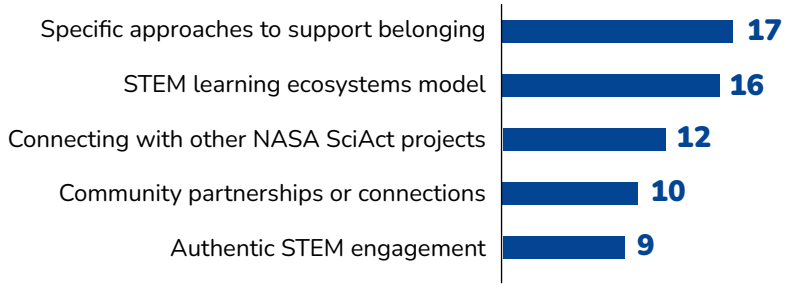
Meeting attendees explore what learning means to them during one of the Tempe meeting's plenary sessions.

Interest and intent to apply learnings

Webinars and in-person meetings sparked attendees' interest and intent to apply what they learned to their own work. Many attendees reported being more confident in their understanding of principles and practices related to the key ideas.

After the webinars, attendees were interested in learning more about approaches to support belonging, the STEM learning ecosystem model, and ways to connect with other NASA SciAct projects.

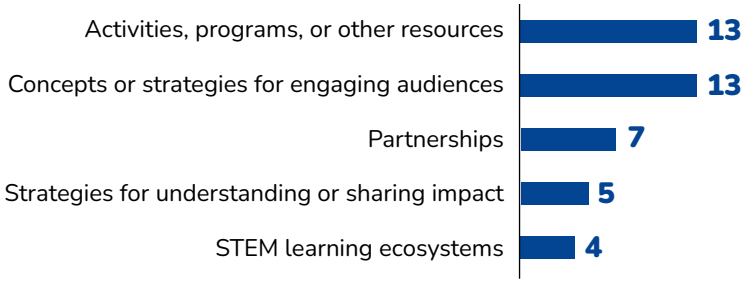
"What is something from today's meeting that you're interested in following up on?"
(n=33)



> *"[I'm interested in] following up on the construct of Belonging and how it is measured/ captured."*
>
> –WEBINAR ATTENDEE

Most in-person meeting attendees agreed that they learned about resources, approaches to support partnerships or STEM engagement, and/or ways to strengthen local collaborations.

"Through the in-person meeting, I learned about..."
(n=35)



Saint Paul meeting attendees learned about resources from other NASA SciAct projects, such as GLOBE, NASA@ My Library, NISE Network, and Space Telescope Science Institute, through the meeting showcase.

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SUGGESTED CITATION

Anderson, A., Atwood, A., & Kollmann, E. K. (2026). SciAct STEM Ecosystems Summative Evaluation. Boston, MA: Museum of Science for Arizona State University.

https://www.nisenet.org/SciAct-STEM-learning-ecosystems-summative-evaluation

1. Introduction

1.1 Project overview

The *SciAct STEM Ecosystems to Broaden Participation in Authentic STEM Learning: Connecting Subject Matter Experts, Communities, and Learners of All Ages* ("SciAct STEM Ecosystems") project was developed to understand and share principles and practices used by learning ecosystems to broaden participation in science technology, engineering, and math (STEM). The team was led by the Center for Innovation in Informal STEM Learning at Arizona State University, with a core project team that included the Arizona Science Center; Museum of Science, Boston; Sciencenter in Ithaca, NY; Southwestern Community College in North Carolina; University of Alaska Fairbanks; and the National Informal STEM Education (NISE) Network. The Gulf of Maine Research Institute (GMRI) provided support by participating in the inquiry study and collaborating on project activities. The project partners represented four regional collaborations that were studied by this project through the lens of STEM learning ecosystems, shown in Figure 1. These collaborations included:

- Arctic and Earth STEM Integrating GLOBE and NASA (Arctic and Earth SIGNs) anchored at the University of Alaska Fairbanks;
- Rural Activation and Innovation Network (RAIN) led by Arizona Science Center;
- Smoky Mountains STEM Collaborative housed out of Southwestern Community College in North Carolina; and
- Learning Ecosystems Northeast (LENE) coordinated by the Gulf of Maine Research Institute.

Figure 1. Map of regional collaborations that participated in the inquiry study

The project team conducted an inquiry study to explore the principles and practices used by these four collaborative projects ("example ecosystems") to broaden participation in authentic STEM learning. The study involved an iterative process of literature reviews, discussions with advisors, practitioner interviews, and analyses. This process was repeated across three phases; each phase addressed a different research question while also enriching the team's overall understanding across all questions. Learnings were synthesized into three key ideas (Section 1.2, below), which were shared and used to anchor related content in dissemination and project activities. Representatives from the example ecosystems were involved in shaping the direction of the inquiry study and how learnings were shared through webinars and in-person meetings. They were also involved in presenting key ideas along with relevant examples from their own projects at webinars, in-person meetings, and conferences. More information about the inquiry study methods can be found in Kollmann et al., 2025, and information about the project can be found on the NISE Network website: nisenet.org/stem-learning-ecosystems.

The SciAct STEM Ecosystems project was supported by NASA Science Mission Directorate's Science Activation program ("NASA SciAct"). NASA SciAct is a portfolio of projects funded through cooperative agreements with the shared purpose of expanding participation in NASA Earth and space science across the United States. In addition to identifying principles and practices from STEM learning ecosystems, a major focus of the project was to increase collaboration and share knowledge among projects in the NASA SciAct portfolio and to disseminate findings broadly across the STEM education and engagement field, contributing to NASA SciAct mid-level objectives 4a and 4b that focused on amplifying the impacts of individual efforts in the portfolio and leveraging national networks. The project team planned and implemented webinars and in-person meetings to promote integration across NASA SciAct and disseminate findings more broadly. Additional activities included sharing project results at professional conferences and through publications.

The summative evaluation focused on understanding the impacts of the dissemination of project findings on professionals who participated in webinars and in-person meetings. This report contains the top-level key ideas shared with participants, along with information about these project activities and related resources.

1.2 Key ideas

Presented as key ideas, findings from the inquiry study were shared at webinars and in-person meetings to support collaborative learning between participants. The key ideas focus on the practices or structures cultivated by a STEM learning ecosystem that is intentionally designed to broaden participation in STEM. The team also recognized that these ideas are useful to projects and partnerships that are not organized as a learning ecosystem but are pursuing similar goals. At webinars and in-person meetings, key ideas were often presented alongside stories from the example ecosystems. The level of detail shared depended on the format, participants, and timing. For example, shorter events focused on sharing high-level information, while longer events were able to provide more detail and sub-findings. Language was adjusted as the project team shared the key ideas, to promote understanding and clarity. The key ideas are shown in Figure 2, below.

Figure 2. Key ideas

Community

STEM learning ecosystems are built and sustained through intentional practices; thrive through reciprocal relationships; and are grounded in their geographic and cultural context.

Belonging:

Ecosystems can broaden participation by cultivating genuine relationships among individuals and organizations; creating a flexible and transparent culture; sharing programming and resources; and prioritizing a sense of belonging.

Engagement:

Authentic STEM engagement starts with understanding what is relevant to learners and communities, then creates connections to content through active learning experiences.

Relevance:
Connects to identity and culture, promotes a sense of belonging, and fosters inclusion.

STEM content:
Includes community observations, scientific data, assets, and a range of expert perspectives.

Experience design:
Supports active learning, encourages dialogue, and builds on community strengths.

1.3 Activities and resources

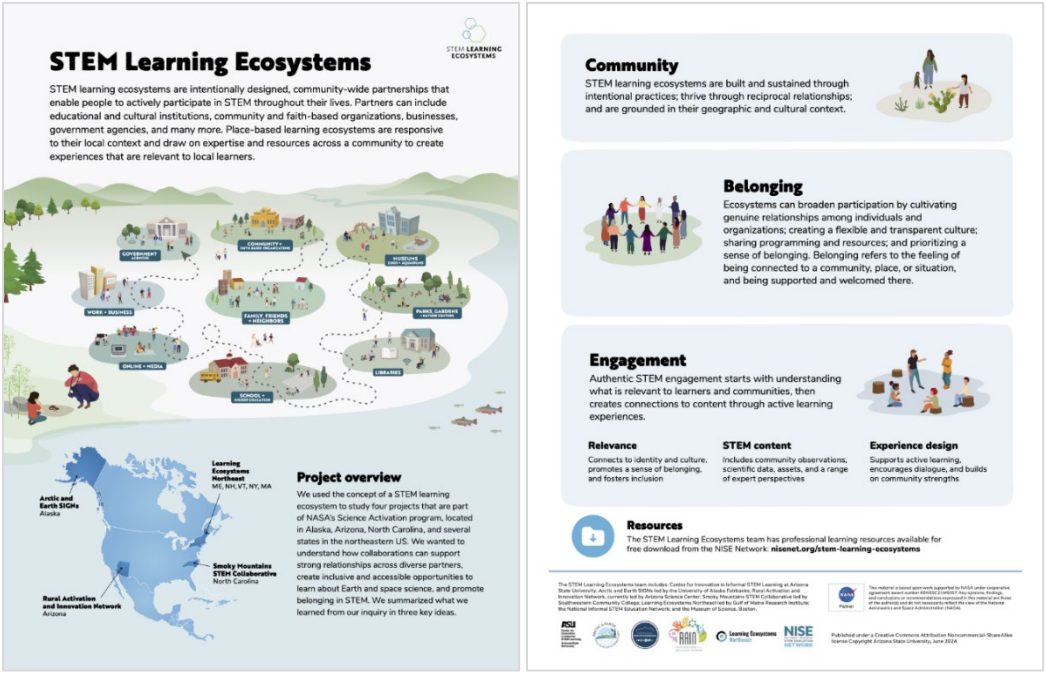
As a part of the SciAct STEM Ecosystem project, the team hosted multiple webinars and two in-person meetings, along with developing related professional learning resources. These were designed to share the key ideas from the inquiry study with other SciAct grantees and the broader informal science education field.

Professional learning resources

The SciAct STEM Ecosystems project team produced concise resources to share the key ideas and developed activities to support conversation and engagement during webinars and in-person meetings. These activities were not individually evaluated but were part of the resources offered to professional development participants and were referenced by study participants. All resources are hosted on the NISE Network website.

A **two-page project overview** that briefly summarized the key ideas was used as a handout for in-person meetings or sharing an overview of what was learned through the project (Figure 3).[1] A series of five professional learning videos were created to share the key ideas in the words of the ecosystem practitioners and team members (Figure 4).[2] In each video, members of the project team explained the key ideas or gave examples from their own ecosystem, to provide additional insight and framing. A reflection and discussion guide was shared on the NISE Network website that supported further engagement with the videos. At the end of the project, an additional video was created about ecosystems, belonging, and STEM engagement using stories from in-person meeting attendees.

Figure 3. Project summary handout



[1] https://www.nisenet.org/catalog/stem-learning-ecosystems-project-overview

[2] https://www.nisenet.org/stem-learning-ecosystems-videos

Figure 4. Professional learning video, title and example frame

The **"Depict Your Partnership" activity** was created to support discussions around STEM learning ecosystems (Figure 5).[3] In this activity, people represent their partnerships or ecosystems through a drawing, identifying resources, partners, activities, or other elements, using a using a template with a tree or watershed as a metaphor (or coming up with their own). This activity was used at in-person meetings and conferences, followed by group conversations to share and discuss what each individual or team drew.

Figure 5. Tree template and example for "Depict Your Partnership"

The project team also produced two conversation starter activities, using custom card decks to prompt discussion. **"What is Learning"** is an icebreaker-style activity that prompts people to think about what learning can look like.[4] This activity was inspired by an exercise developed by Connie Schroeder, PhD, at the Center for Excellence in Teaching and Learning, University of Wisconsin-Milwaukee. The "What is Learning" deck includes 62 cards, with a range of images such as an aerial view of winding road, a window, weaving, broken pottery, tangled ropes, and more (Figure 6). Participants are

[3] https://nisenet.org/catalog/depict-your-partnership

[4] https://nisenet.org/learningcards

directed to select an image that symbolizes how they think about learning, and then to share their picture with others and explain why it represents learning to them.

Figure 6. Example "What is Learning" cards

"What Values Do You Share" is a discussion activity that prompts people to explore their values with partners.[5] This deck includes 57 cards, with a few blank cards. Each card has a value word in English and Spanish accompanied by a related image, including cards such as "Persistence / Persistencia" over a picture of a plant growing in a sidewalk seam, "Hardworking / Trabajado arduo" over a picture of a honey bees, "Integrity / Integridad" over an image of a an aqueduct, and more (Figure 7). In this activity, participants are prompted to select a card that expresses values that are important to their partnership or collaborative efforts, share and explain their card to others, and discuss what they notice about the cards people in their group selected.

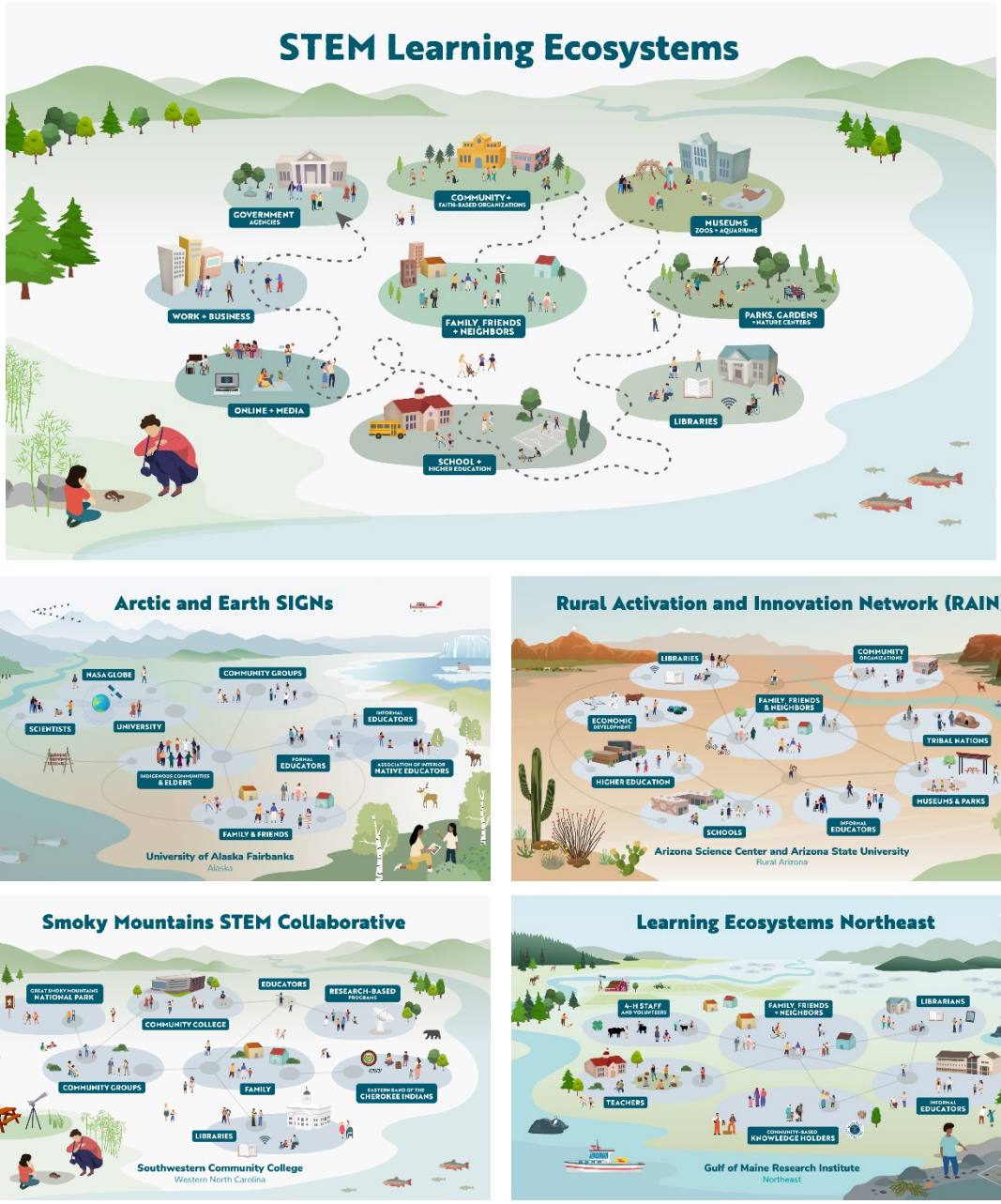
Figure 7. Example "What Values Do You Share" cards.

[5] https://nisenet.org/valuescards

Physical copies of both decks were used at in-person meetings, with participants being given their own copies to take home. Simplified versions, using a smaller set of images, were used during webinars. In addition to the physical copies that were given away, the cards and supporting materials are also available on the NISE Network website for people to print themselves.

The **illustration of a generalized STEM learning ecosystem** included in the project summary handout was also available as an editable template for others to use. The team created a postcard with this image to help share information about the project. Typically, the generalized illustration was shared during presentations when introducing the concept of STEM learning ecosystems, along with versions that were customized for the example ecosystems that participated in the inquiry study (Figure 8).

Figure 8. Generalized and customized example ecosystem illustrations



Webinars

The project hosted webinars sharing project findings and making connections to related work. One was held specifically for the NASA SciAct community, while a series of webinars were offered for the broader STEM education and engagement community through the NISE Network.

In May 2024, a 90-minute webinar was held for the NASA SciAct community, with two separate session dates available to accommodate team schedules. Both sessions included the same content: sharing key ideas from the SciAct STEM Ecosystems project; facilitating group discussions to support understanding of the key ideas; and exploring connections across the NASA SciAct portfolio. After introducing the team and project, the webinar was divided into three sections, each exploring one of the key findings. Section 1 shared the Engagement key idea and included breakout rooms for participants to discuss a digital version of the "What is Learning" conversation starter activity described above. Section 2 focused on the Community key idea, sharing a generic visualization of a STEM learning ecosystem to highlight typical structures and partners involved. Project-specific examples from the collaborations that were part of the inquiry study were also added to emphasize the variation and importance of incorporating local contexts. In breakout groups, participants discussed how their work is connected with STEM learning ecosystems. Section 3 addressed the Belonging key idea, primarily addressing the organizational structures and practices STEM learning ecosystems can use to broaden participation and foster feelings of belonging in both partners and audiences. During this section, participants were invited to share in the online chat function how these practices related to their work. A final reflection prompt was used to wrap up the webinar and collect data for this summative evaluation.

A series of three 60-minute webinars were hosted through the NISE Network's regular online workshop series, reaching a broader audience of STEM education and engagement professionals. [6] These three webinars were held between February and April 2025, and used the inquiry findings to frame and connect the series. The first webinar, *Introduction to STEM Learning Ecosystems - Principles and Practices for Community-wide Partnerships*, briefly provided an overview of the concept of STEM learning ecosystems and shared how the model can be used to create greater impact within communities. Presenters shared the key ideas, along with brief stories about the practices in action from the example ecosystems. Participants were invited to share reflections about what they heard during the workshop in the chat. These reflections were gathered as data for the summative evaluation. The second and third workshops were framed using the key ideas from the SciAct STEM Ecosystems project and included speakers outside the project to highlight the broader applicability of findings. In *Museum Experiences Participating in STEM Learning Ecosystems*, three speakers talked about their organizations' roles in their local STEM learning ecosystems. A representative of the national STEM Ecosystems initiative (stemecosystems.org) shared

[6] Workshop recordings and slides available on the NISE Network website: www.nisenet.org/catalog/online-workshop-recording-intro-stem-ecosystems; www.nisenet.org/catalog/online-workshop-recording-museum-experiences-2025;

www.nisenet.org/online-workshop-relevantSTEM2025

resources to help connect participants to ecosystems in their areas. The last workshop in the series, *Creating Relevant and Meaningful STEM Experiences*, focused on making STEM relevant for learners, providing examples for adapting existing learning experiences and creating new ones. To wrap up the workshop, these approaches were connected to the key ideas from the SciAct STEM Ecosystems project.

In-person meetings

The SciAct STEM Ecosystems project hosted two in-person meetings, one in Tempe, Arizona and one in Saint Paul, Minnesota. Both meetings were invitation-only, with participant travel supported by the project. Attendees represented a variety of NASA SciAct projects, NASA SciAct leadership, and SciAct STEM Ecosystems project advisors. At the Saint Paul meeting, representatives from partner organizations connected to NASA SciAct projects and projects doing related work were also included. Each in-person meeting was a day and a half in length and included plenary sessions with presentations and participatory activities, concurrent sessions, a resource showcase, networking opportunities, and shared meals. In addition to sessions and activities to support connection, the meeting provided time for attendees to interact with each other. For each meeting, participants received a packet that included the meeting goals and agenda, resource lists, wayfinding information, and attendee contact information.

The SciAct STEM Learning Ecosystems Meeting ("2024 Tempe meeting") was held January 16–18, 2024, in Tempe, Arizona, and focused on bringing together core team members from NASA SciAct projects that were either already connected to a STEM learning ecosystem or were doing work that could support a STEM learning ecosystem. During the plenary sessions of this meeting, the SciAct STEM Ecosystems project team presented the key ideas from the inquiry study and provided examples. Attendees related the ideas to their own work through table discussions, using the "Depict Your Partnership" activity and the "What is Learning?" activity. Participants both presented at and attended concurrent sessions, with topics organized using this project's key ideas, to facilitate sharing and learning insights with others.

As shared with participants, the meeting goals were to:

- Share findings from SciAct STEM Ecosystems and explore connections to work across NASA SciAct;
- Share and learn ways to broaden participation in authentic STEM learning;
- Strengthen relationships among NASA SciAct teams;
- Reflect on team activities and plans, with the goal of improving our work; and
- Help plan future engagement among this group, our teams, and our extended networks.

The STEM Learning Ecosystems and Community Partnership Meeting ("2025 Saint Paul meeting") was held August 4-6, 2025, in Saint Paul, Minnesota, and focused on further exploring the practices and partnerships that were introduced in the 2024 Tempe meeting. Meeting attendees for the second meeting included NASA SciAct team members whose work aligned with the meeting's focus, as well as those with more diverse roles and expertise in STEM learning ecosystems, such as educators and community organizers. During the 2025 Saint Paul meeting, the key ideas were briefly shared at a high level and used to organize concurrent session tracks. Similar to the 2024 Tempe meeting, attendees were invited to lead and participate in concurrent sessions and a resource showcase.

As shared with participants, the meeting goals were:

- **Reciprocal partnerships:** Participants will learn about ways to create effective partnerships;
- **STEM engagement**: Participants will learn about ways to engage all Americans in Earth and space science;
- **Reflect:** Participants will reflect on approaches they can apply in their own work;
- **Content and resources**: Participants will learn about resources they can use in their own work;
- **Inspiration:** Participants will be inspired and motivated by approaches they learned about at the meeting; and
- **Community**: Participants will strengthen connections to other meeting attendees.

Additional Dissemination

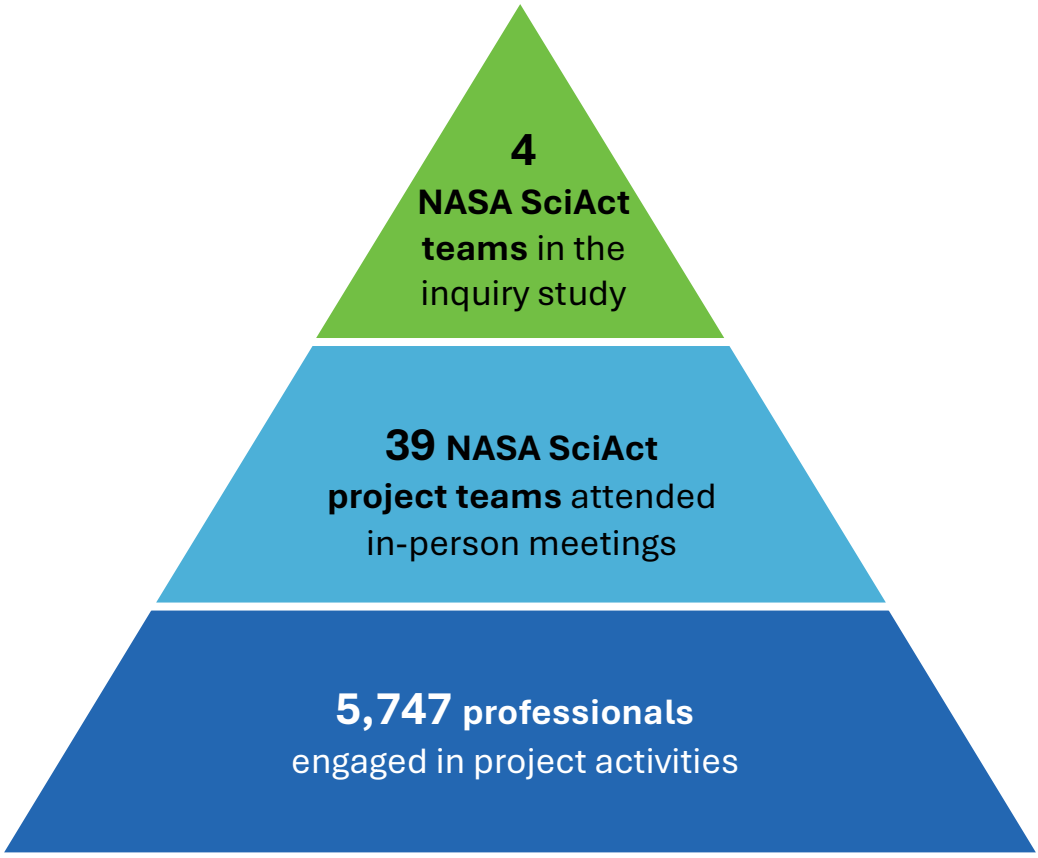
Findings were also disseminated at many conferences for professional organizations, such as the American Geophysical Union, Association of Science and Technology Centers, STEM Ecosystems Community of Practice, and Visitor Studies Association. Due to the nature of these experiences and the audiences involved, they were not included in the summative evaluation.

The core project team found that participation in the inquiry study impacted their approach to their own work. This team met at least once a month and were heavily involved in the inquiry study by contributing to the study questions and interview design; participating as study subjects; shaping interpretations; and disseminating findings through conference presentations and publications. Informal reflections during regular meetings highlighted how the process of being involved in the study impacted team members' own work and practices, which led to more formal discussions about the impacts on those closest to the project. Reflections about the study methods, including discussion about incorporating contextually responsive evaluation methods to collect useful data, have been shared in an article by the research team (Kollmann et at., 2025). A longer publication discussing the key findings in detail and sharing case stories from the example ecosystem is in progress at the time of this report.

1.4. Project reach

Through webinars, online workshops, in-person meetings, conferences, and other activities, the project engaged 39 NASA SciAct projects and 5,747 STEM engagement professionals over three years (Figure 9). The SciAct STEM Ecosystems project had multiple professional audiences, with different levels of engagement for each group. Professionals from the four example ecosystems were the most deeply involved, throughout the entire project. They were a part of the core project team and participated in the inquiry study. Teams from the broader NASA SciAct community were deeply involved for short periods of time, attending in-person meetings and sharing their project work at the showcases during the meetings. Attendees at the in-person meetings represented 39 NASA SciAct teams. The broadest audience interacted through other dissemination activities, such as webinars and conference sessions, where they learned about the key ideas and engaged with resources from the SciAct STEM Ecosystems project. Ultimately, 5,747 professionals participated in these dissemination activities.

Figure 9. Project reach



2. Methods

The summative evaluation focused on understanding the impacts on participants of the webinars and in-person meetings. The overarching evaluation question for the study was:

> *How do the professional development deliverables increase participants' knowledge of, confidence in utilizing, and intention to use STEM learning ecosystem principles and practices to broaden participation in authentic STEM learning?*

As described above, each professional learning experience offered different ways to engage with the key ideas, and had specific goals and outcomes, outlined in Section 1. Due to these differences, evaluation methods varied by mode of engagement. Summative evaluation protocols were reviewed and approved by the Heartland Institutional Review Board, under project number 081723-507.

Webinars

The NASA SciAct community webinar and first NISE Network webinar were relatively short and covered the key ideas at a high level. Because of this, data collection was embedded in the experience as polls and chat reflections, rather than asking attendees to complete a longer survey. During these webinars, attendees were informed which parts would (and would not) be included in the evaluation efforts. At the beginning of these sessions, participants were asked for some information about themselves to provide context about who attended and the amount of familiarity they had with the principles and practices of STEM learning ecosystems. This also helped presenters and participants get to know each other. At the end of the webinar, participants were asked to share a final reflection in the meeting chat about how the information resonated with them or what they wanted to learn more about, which was used for evaluation. The second and third NISE Network webinars used the key ideas as themes to invite speakers from other projects to be the focus of the content, so were outside the scope of this evaluation. Ultimately, 64 attendees at the NASA SciAct community webinar and 52 attendees at the NISE Network webinar responded to the poll questions and/or open-ended reflections. In this report, quantitative data were analyzed using descriptive statistics, while the open-ended reflections were coded inductively (Patton, 2002).

In-person meetings

Summative evaluation data for the in-person meetings were collected through online surveys after each event. Meeting attendees were told about the evaluation during the meeting and then received an email afterwards with a personalized survey link. Almost all attendees were invited to fill out the survey, except SciAct STEM Ecosystems project team members and advisors.

For the 2024 Tempe meeting, attendees were sent two surveys, one directly after the meeting ("post-event survey"), and one following up with participants approximately two months later ("follow-up survey"). The post-event survey was used to measure short-term outcomes and impacts on meeting attendees. It focused on participants':

- Understanding of STEM learning ecosystems and their principles and practices related to broadening participation in authentic STEM engagement;
- Feeling that these principles and practices are informative to their work;

- Interest in continuing to learn about, use, and share these principles and practices; and
- Opportunities to connect with others in the NASA SciAct community.

Since the meeting included a lot of information, and some goals were related to applying the learnings after the meeting, the follow-up survey looked at impacts after attendees were able to digest and potentially share or apply what they learned. It focused on understanding if and how the meeting contributed to professionals':

- Intention to use what they learned related to STEM learning ecosystems in current or future work;
- Barriers or challenges in using what they learned related to STEM learning ecosystems; and
- Impact of connections made at the meeting with other NASA SciAct projects or through learning from other attendees.

Ultimately, 31 attendees completed the Tempe meeting post-event survey, with 19 of these also filling out the later follow-up survey. Quantitative data related to attendees' confidence in their understanding of and ability to use practices and principles of STEM learning ecosystems were analyzed using inferential statistics, while all other quantitative data were analyzed through descriptive statistics (Rosenthal 1991). Qualitative data were primarily analyzed using inductive coding (Patton 2002); however, some questions related to learning principles or practices were deductively coded using key ideas presented during the meeting as starting codes (Fereday & Muir-Cochrane, 2006).

For the 2025 Saint Paul meeting, attendees were sent one survey directly after the meeting ("post-event survey"). This survey focused on measuring short-term outcomes on participants':

- Ability to share and learn ways to create effective partnerships and engage learners in Earth and space science;
- Feeling inspired and motivated by the resources and approaches shared during the meeting; and
- Making connections with each other.

A total of 42 attendees completed the Saint Paul post-event survey. Quantitative data were analyzed through descriptive statistics, while the open-ended reflections were analyzed inductively (Patton, 2002).

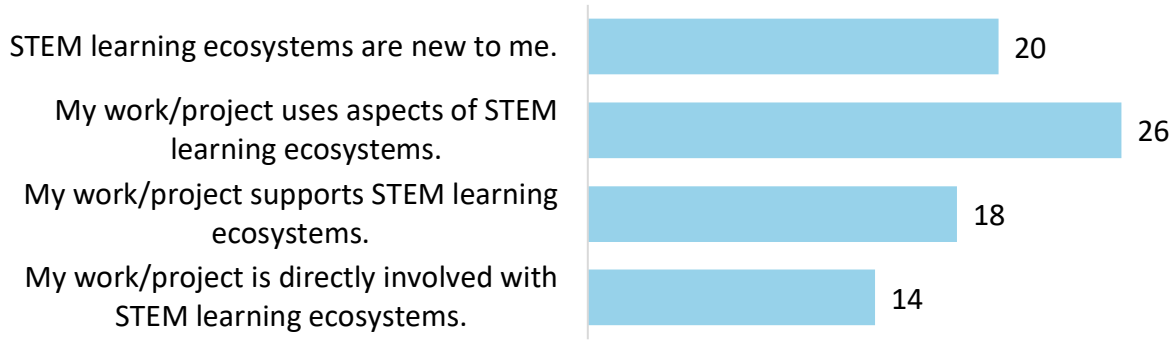
3. Findings: Virtual Gatherings

3.1 NASA SciAct community webinar

The NASA SciAct community webinar was open to people connected to any NASA SciAct project or infrastructure team, with specific encouragement for those who did not attend the in-person 2024 Tempe meeting. Two webinar sessions were held to accommodate schedules, and responses were aggregated across both sessions. To help contextualize the open-ended reflections collected at the end of the sessions, attendees were asked questions about their level of involvement with NASA SciAct work, their professional role(s), and their experience with STEM learning ecosystems. All webinar attendees reported they were at least a little involved with a NASA SciAct project as part of their daily work, with most (44 of 60) respondents saying that they were "very involved" with their NASA SciAct projects, and the rest (16 of 60) saying that they were "a little involved." Attendees represented a variety of roles, most commonly identifying as educators (30 of 62), project administrators (29 of 64), and/or engagement or outreach professionals (27 of 64), with about half selecting more than one option (Figure 10). Most respondents said they were familiar with the STEM learning ecosystem model in some way (Figure 11). Most frequently, respondents (26 of 64) said this was because their project or work uses some aspects of the STEM learning ecosystems model.

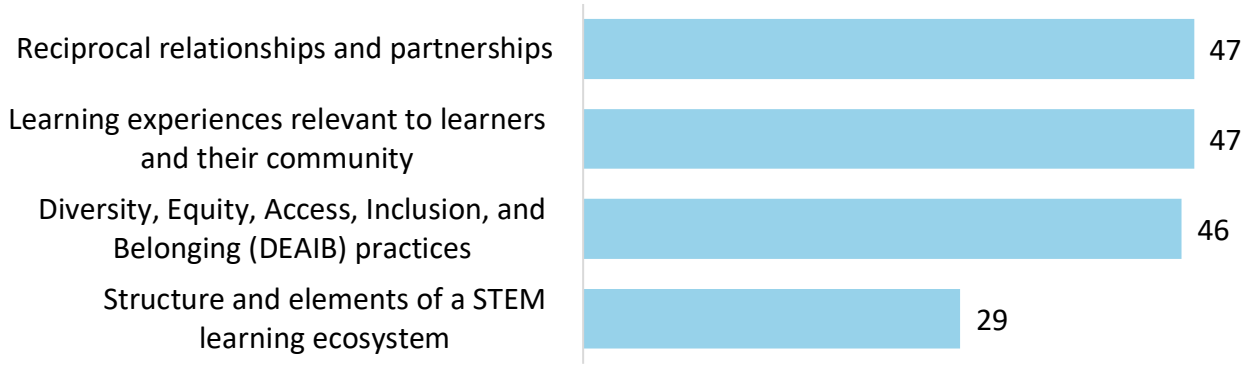
Figure 10. How do you identify as a professional within the project that you are representing today? (n=64)

Figure 11. Which statement(s) best describes your familiarity with principles and practices of STEM learning ecosystems? (n=59)



At the end of the webinar, attendees were asked to reflect on what they had heard about the key ideas shared by the SciAct STEM Ecosystems project. When asked which topics discussed during the webinar were most relevant, many participants selected multiple options. Almost all participants said that the topics of reciprocal relationships and partnerships (47 of 53 respondents), practices related to belonging (46 of 53 respondents), and creating learning experiences relevant to learners (47 of 53 respondents) were related to their work in SciAct or beyond. Fewer participants (29 of 53) said that they felt the structures and elements of a STEM learning ecosystem were relevant to their work; however, this was still more than half of the webinar participants (Figure 12).

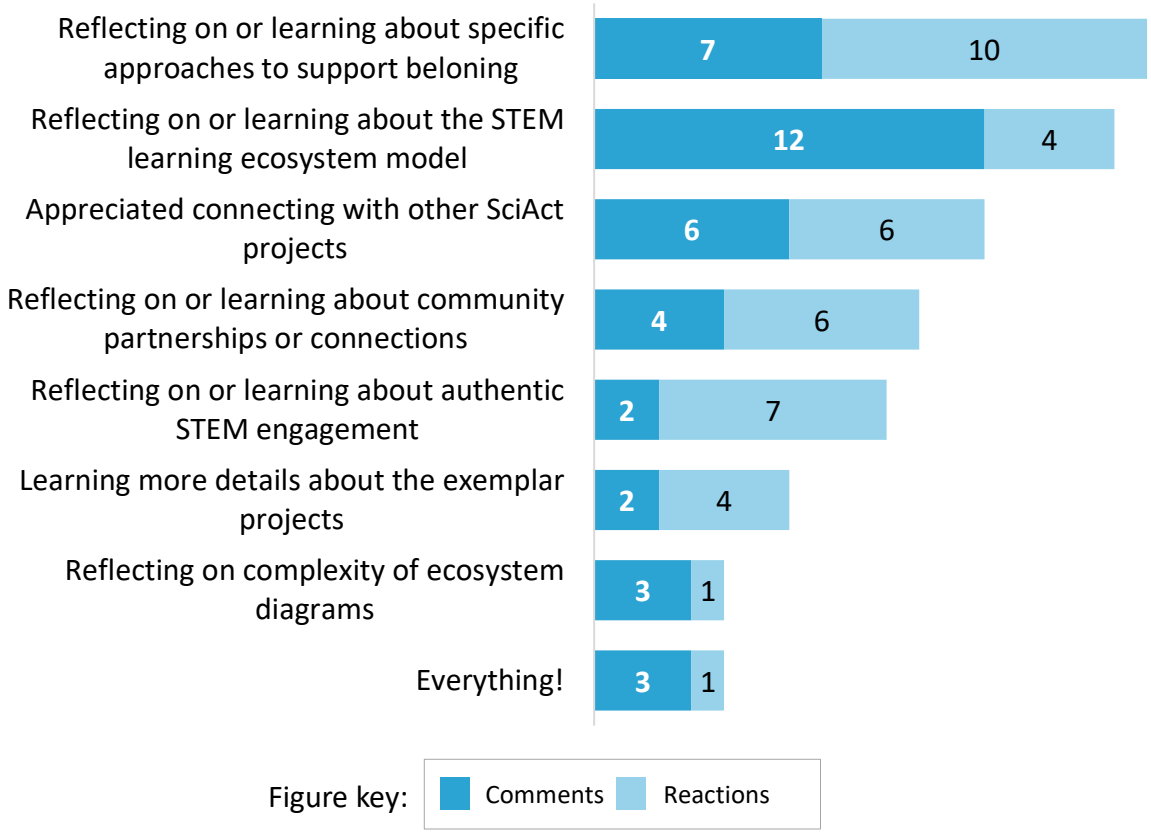
Figure 12. Which topics about STEM learning ecosystems are related to your work in SciAct or beyond? (n=53)[7]



The SciAct STEM Ecosystems project team was interested in what aspects of the key ideas or other content most resonated with attendees. As a final reflection, attendees were asked to respond to one of two questions, recognizing that different levels of familiarity with or use of the STEM learning ecosystem model might influence what participants take away from the webinar. They were asked to enter their reflection in the webinar's chat, responding to prompts about information they wanted to follow-up on after the webinar or if the STEM learning ecosystem model resonated in new ways. Since attendees were responding in the webinar chat, people were also able to react to their colleagues' comments (e.g., adding a heart or thumbs up emoji). Attendees most commonly (12 of 33, with 4 positive reactions) talked about understanding or reflecting on the STEM learning ecosystem model after the webinar. One person said, *"I definitely want to think about and reflect upon STEM Ecosystems as a whole including where a project 'falls' within an ecosystem."* Some participants (7 of 33, with 10 positive reactions) also discussed wanting to follow-up on specific approaches used to support feelings of belonging in their audiences. One participant said, *"[I am] thinking more about accessibility - who we're accidentally leaving out, even when well intentioned, and how to improve accessibility throughout the work we do."* Comments about specific approaches around belonging or authentic engagement received the most reactions from participants. Figure 13 below shows the most common responses from participants, along with how many people shared a positive reaction to those responses.

[7] These data were collected in 2024 and may not reflect current policy or program focus.

Figure 13. Open-ended responses to "What is something from today's meeting that you're interested in following up on?" OR "Does the concept of STEM learning ecosystems resonate with you in any new ways? How?" (n=33)

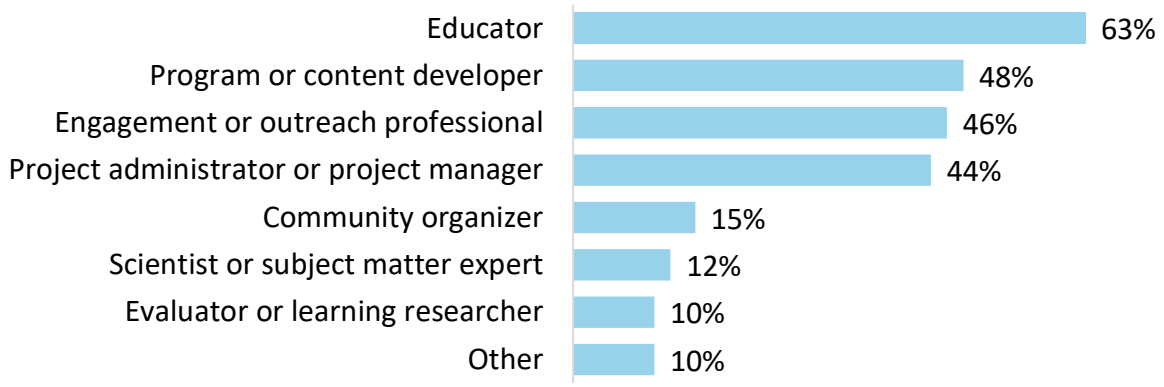


3.2 NISE Network webinars

Using the project's key ideas as a framework to gather partners to share their work with others, three webinars were offered through the NISE Network online workshop series, reaching the broader STEM education and engagement community. The first webinar (*Introduction to STEM Learning Ecosystems - Principles and Practices for Community-wide Partnerships*) focused on sharing the key ideas from the SciAct STEM Ecosystems inquiry study. The other two webinars used the key ideas as an organizing framework to invite speakers from the broader STEM engagement community to share examples from their own work. The findings below represent data from the first webinar that directly shared learnings from the SciAct STEM Ecosystems project.

Attendees at the first webinar most frequently self-identified as educators (63%), program or content developers (48%), and engagement or outreach professionals (46%), with many participants selecting multiple categories (Figure 14). About a third (35%, n=52) of attendees were new to the concept of a STEM learning ecosystem, while some (20%) were familiar with the model but did not use it in their own work. The rest either were directly involved in a STEM learning ecosystem (25%), did work that supports a STEM learning ecosystem (15%), or utilized some of the practices that are used in the STEM learning ecosystem model (8%).

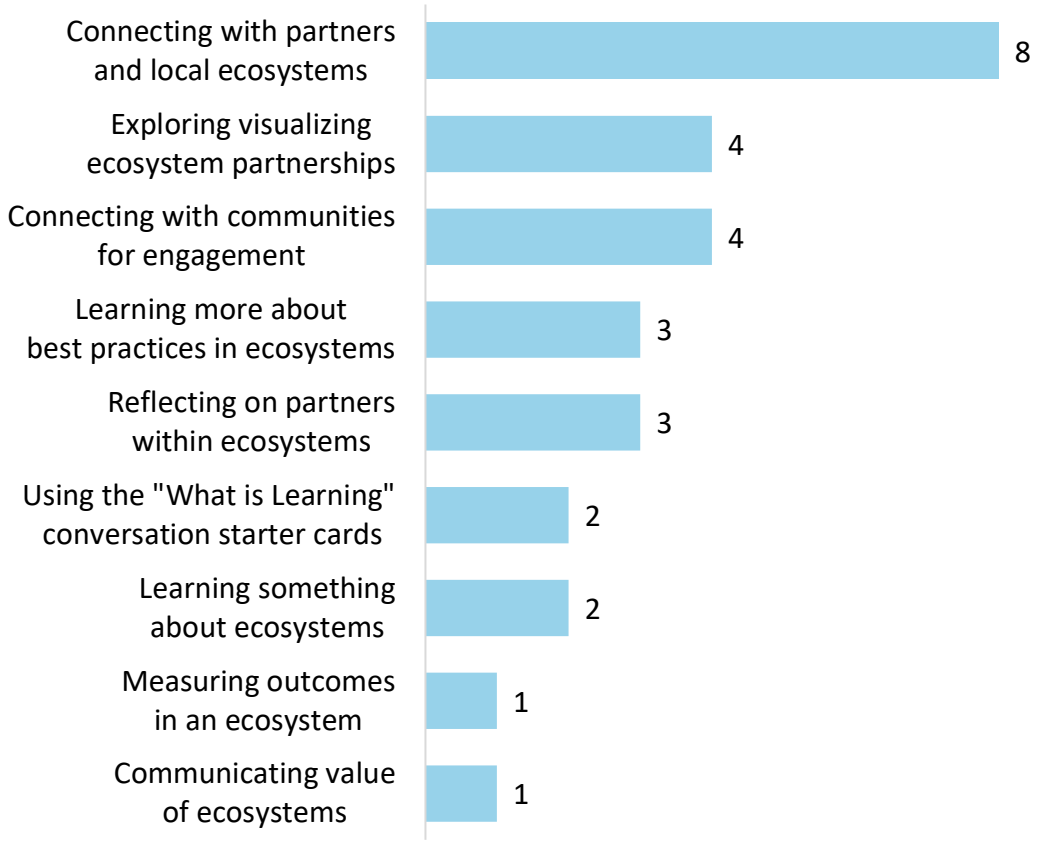
Figure 14. How do you identify as a professional within the project that you are representing today? (n=52)



At the end of the first webinar, participants were asked to reflect on what they learned during the presentation. Using the same questions from the NASA SciAct community webinar, they were asked what they were interested in following up on or if the STEM learning ecosystem model resonated with them in new ways. Unlike the pervious webinar, no participants chose to leave a reaction on someone else's comment. Responses indicated that attendees were interested in following up with many different aspects of the meeting, see Figure 15. Most commonly, participants shared that they were interested in connecting with partners and local STEM learning ecosystems (8 of 27), with one person sharing *"How to grow the STEM ecosystem at a public library system and branch level."* They also talked about connecting with communities around engagement or outreach (4 of 27). Some participants talked about the resources presented during the webinar, such as intending to use the "Depict Your Partnership"

activity or ecosystem illustrations to explore visualizing ecosystem partnerships (4 of 27) or using the "What is Learning" activity with partners (2 of 27).

Figure 15. Open-ended responses to "What is something from today's meeting that you're interested in following up on?" OR "Does the concept of STEM learning ecosystems resonate with you in any new ways? How?" (n=27)



4. In-Person Meetings Findings

Findings from each in-person meeting are presented separately since they had different audiences and goals. Findings from the Tempe meeting in 2024 with NASA SciAct project teams are shared first, followed by findings from the Saint Paul meeting in 2025 that included NASA SciAct teams and their partners.

4.1 SciAct STEM Learning Ecosystems Meeting

The first in-person meeting, the SciAct STEM Learning Ecosystems Meeting or "2024 Tempe meeting," was held in January 2024, in Tempe, Arizona. The meeting was focused on sharing best practices for partnerships and programs that are designed to broaden participation in STEM learning, especially as they related to Earth and space science. Goals for the meeting were that participants would:

- Understand principles and practices of learning ecosystems that work to broaden participation in authentic STEM learning;
- Recognize the relevance of these STEM learning ecosystem principles and practices to their work;
- Gain confidence in their ability to use these principles and practices in their work;
- Build connections and strengthen relationships among NASA SciAct teams; and
- Intend to use relevant practices, principles, resources, or connections in their work.

4.1.1 The 2024 Tempe meeting brought together teams from the NASA SciAct community to learn about and discuss practices related to STEM learning ecosystems.

Approximately 80 people representing a variety of NASA SciAct projects, advisors, and the SciAct STEM Ecosystems project team attended the meeting. Many NASA SciAct projects had multiple representatives at the meeting – and some participants represented more than one project. Excluding the SciAct STEM Ecosystems project's core team and advisors, 31 of 55 attendees responded to the post-event survey (56% response rate). Attendees represented a variety of project roles and responsibilities, with over half selecting two or more roles to represent their professional responsibilities. Most commonly, attendees indicated that they were project administrators or project managers (18 of 31), engagement or outreach professionals (15 of 31), or educators (15 of 31), see Figure 16.

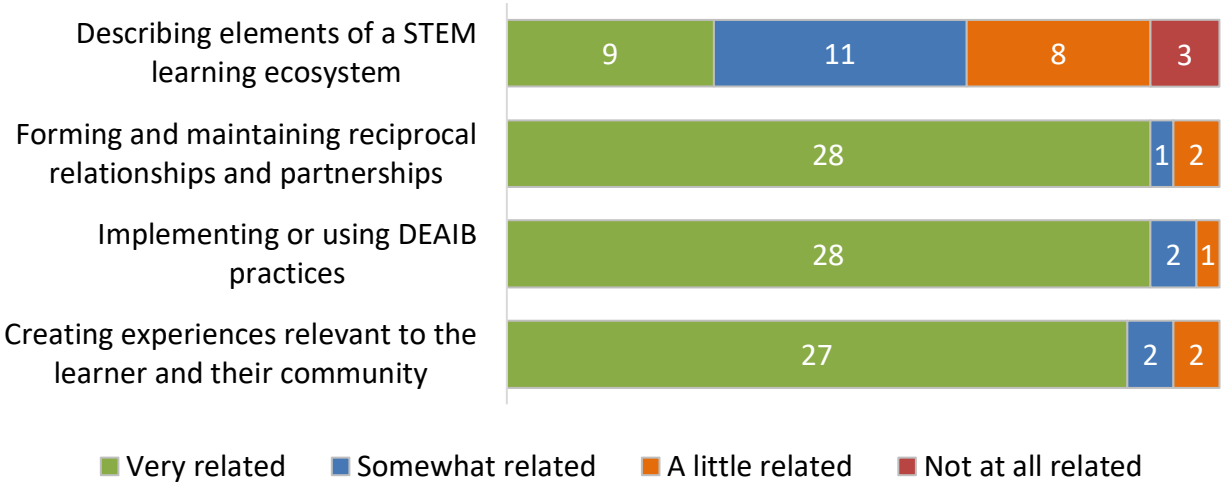
Additionally, most attendees reported they were very involved in their NASA SciAct project and had been for a long time. About two-thirds (21 of 30) of attendees indicated that they were very involved in the NASA SciAct project they represented, with the rest saying they were a little involved (9 of 30). Attendees were typically those that had been working on NASA SciAct projects for a long time, with most people (26 of 31) indicating that they had been involved since the first funding cycle (i.e., for over nine years).

Figure 16. How do you primarily identify as a professional with the project that you were representing at this meeting? (N=31)

4.1.2 Practices related to belonging, partnering, and authentic learning experiences were relevant to attendees, and they felt more confident in their ability to apply these practices because of the 2024 Tempe meeting.

During the 2024 Tempe meeting, attendees learned about practices related to belonging, partnerships, and creating authentic learning experiences. While these practices were discussed within the context of STEM learning ecosystems, they are broadly applicable to engaging communities with STEM content in general. Regardless of whether meeting attendees were currently part of a STEM learning ecosystem, they saw connections between their work and practices used in ecosystems. Being able to describe a STEM learning ecosystem was very related to the work of some attendees (9 of 31), and at least a little related to the work of almost everyone else (28 of 31). All the supporting practices were seen as highly connected to attendee's work with almost all saying that the practices related to belonging (28 of 31), partnering (28 of 31), and authentic learning experiences (27 of 31) were very related to their work. The attendees that did not select "very related" agreed these concepts were at least a little related to their work (1 or 2 out of 31 selecting "a little" or "somewhat" related), see Figure 17.

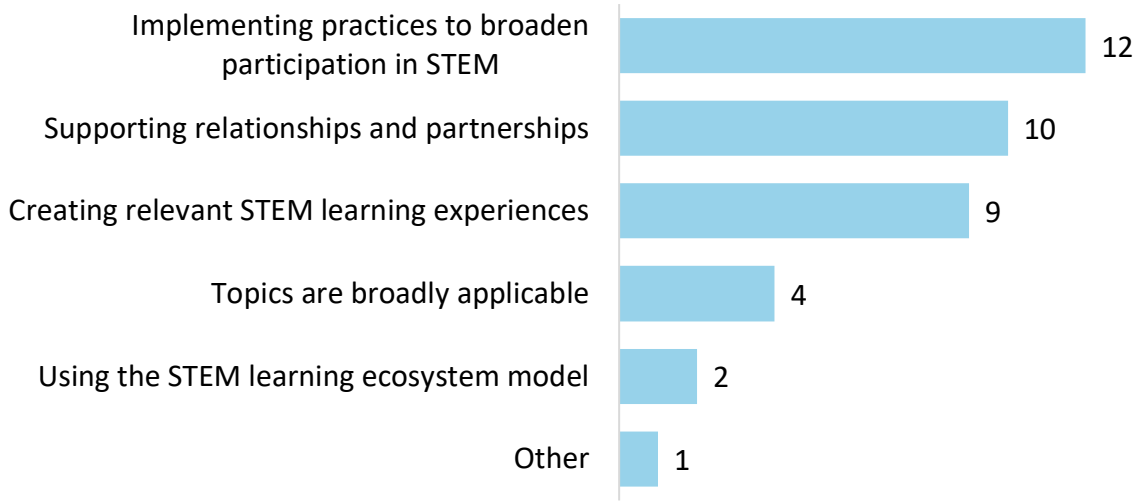
Figure 17. How related are the following topics from the SciAct STEM Learning Ecosystems Meeting to your work in SciAct or beyond? (N=31)[8]



Meeting attendees that selected "somewhat" or "very" related to any of the topics in question above received an open-ended follow up question that asked them to describe how these topics related to their work. Almost all attendees shared how the topics connected to their driving philosophies or principles. Most commonly, attendees (12 of 23) talked about specific practices to support belonging and broadening participation in STEM in their work (Figure 18). For example, one attendee explained that the practices were relevant because *"Everything we do at [our organization] should be open to everyone. This is what we strive for and what we are committed to. By bringing in that sense of belonging, it goes beyond [our typical approach]."* Some attendees (10 of 23) described how the topics were related to their work because it centered around relationships within their communities. One attendee said, "*Much of my work is centered on authentic partnerships with different groups and organizations and conducting STEM engagement with audiences.*" Other participants (9 of 23) talked about how the topics were related because creating authentic STEM experiences was core to their work, which aligns with the broader NASA SciAct goals to engage learners with NASA science. Finally, some participants talked about the topics from the meeting being broadly applicable (4 of 23) or that they found connections because they are a part of a STEM learning ecosystem (2 of 23).

[8] These data were collected in 2024 and may not reflect current policy or program focus.

Figure 18. Open-ended responses to "Please describe how these topics relate to your work." (n=23)



Meeting attendees that selected "a little" or "not at all" related to any of the topics in the rating question had a similar open-ended follow up question that asked them to describe what about these topics felt disconnected to their work. These attendees pointed out how their work was not in complete alignment with the context of the key ideas. They most commonly (6 of 9) said that the topics were not connected because they were not intentionally part of an ecosystem. One of these attendees said, *"We do not focus on STEM ecosystems. I do consider that our work is reflective of multiple intersecting ecosystems - but that is not our focus."* The rest of these participants (3 of 9) shared ways their work connected to the topics but discussed how the practices look different in their particular context.

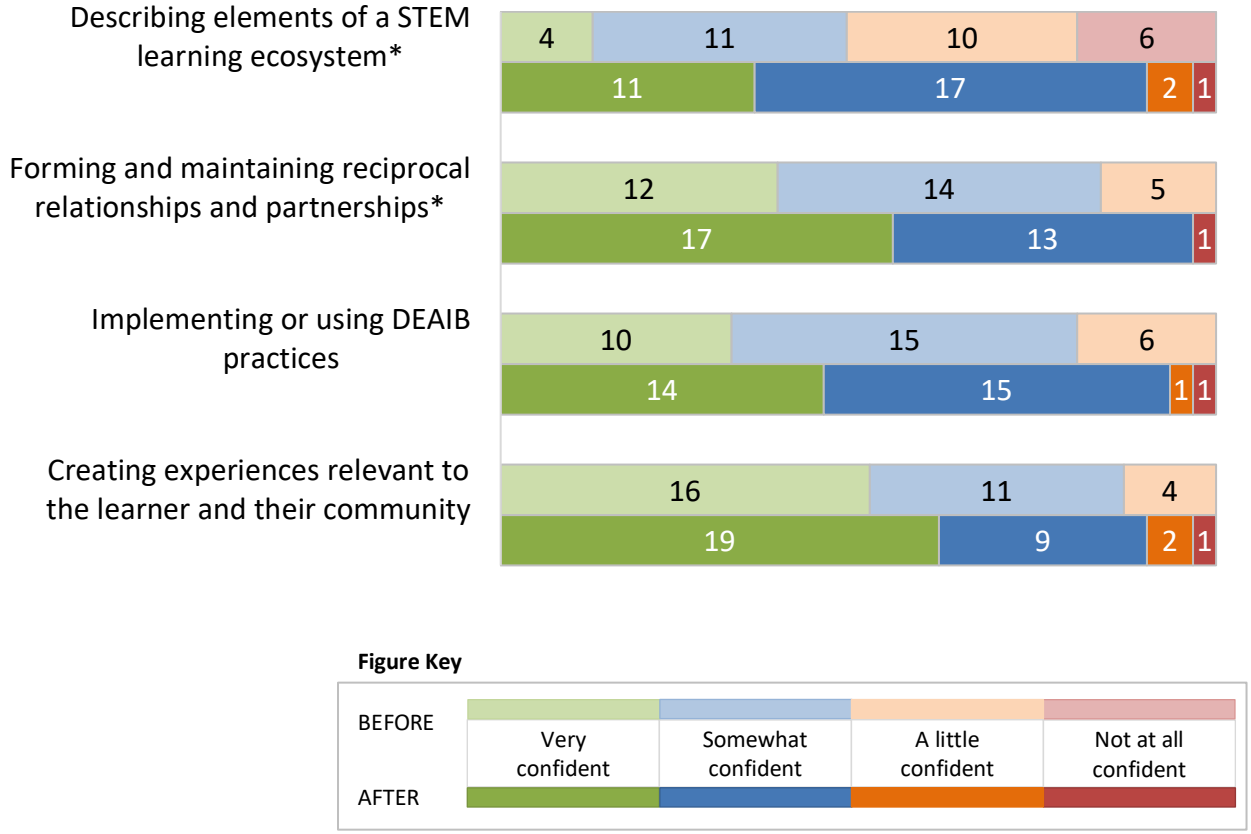
4.1.3 After the 2024 Tempe meeting, attendees were more confident that they understood elements of STEM learning ecosystems.

Information about the STEM learning ecosystem model, elements that shape how they work, and the key ideas from the SciAct STEM Ecosystems project were primarily shared during the plenary sessions. The main plenary topics included developing reciprocal relationships and partnerships, implementing practices that support belonging, and creating relevant learning experiences. Concurrent sessions were organized around these plenary session themes, with meeting attendees sharing related experience and expertise.

Participants were asked retrospective pre/post questions about their confidence in their understanding of different concepts shared during the meeting. About two-thirds of participants indicated that they were more confident in describing elements of a STEM learning ecosystem, with most participants (28 of 31, $p<0.001$) saying they were at least somewhat confident after the meeting, see Figure 19. A smaller, but also statistically significant, group also indicated that their understanding around forming and maintaining reciprocal relationships and partnerships increased, with all but one participant (30 of 31, $p=0.021$) feeling at least somewhat confident after the meeting.

For the more general topic areas, most attendees indicated they had no change, likely reflective of the expertise held by professionals working on NASA SciAct projects.

Figure 19. Please rate how confident you were in your understanding of the following topics [BEFORE / AFTER] attending the Meeting (n=31)[9]



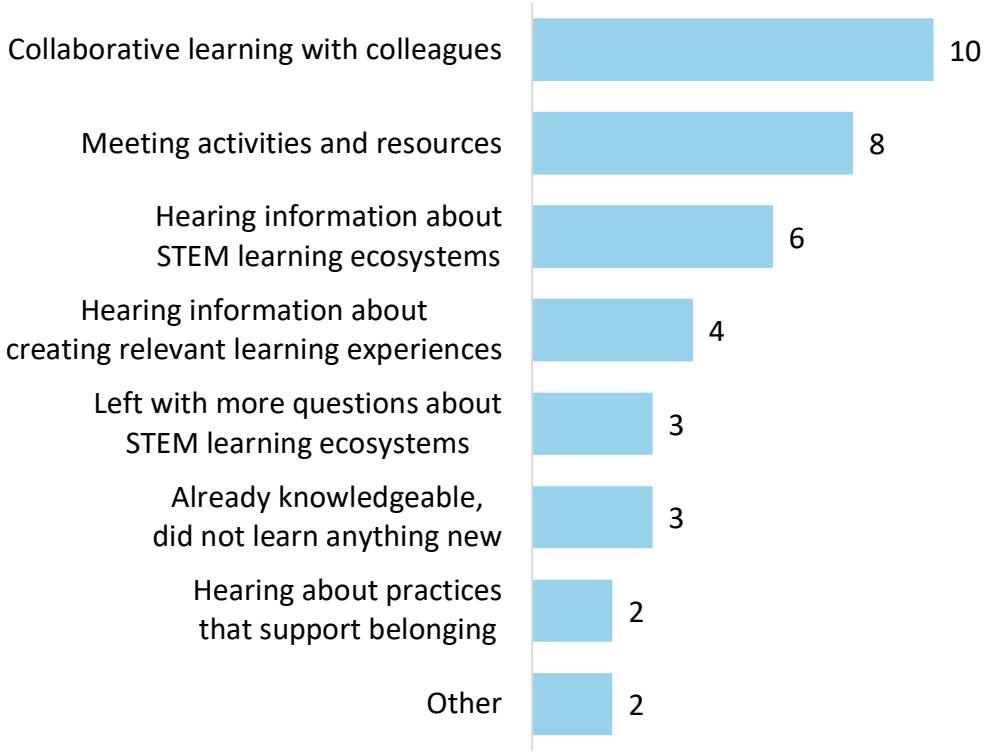
When asked an open-ended question what about the meeting contributed to their understanding, attendees talked about aspects of the meetings or specific topics that resonated with them. Nearly half of respondents (10 of 22) attributed their increased understanding to collaborative learning with colleagues (Figure 20). For example, one attendee said, *"It was especially helpful to have more in-depth conversations with colleagues…"* Other participants (8 of 22) said that the structure or format of the meeting helped their understandings, including the concurrent sessions, specific resources, or conversation activities. One attendee said, *"I really appreciated the key findings that were shared and the videos! I also thought the structure of the meeting was so effective at allowing numerous opportunities to meet so many SciAct colleagues and get to know their work."* Attendees also mentioned some of the content areas that

[9] *Describing elements of a STEM learning ecosystem (Z= -3.814, p<0.001, Negative Ranks: 1; Positive Ranks: 19; Ties: 11)

*Forming and maintaining reciprocal relationships and partnerships (Z= -3.814, p=0.021, Negative Ranks: 0; Positive Ranks: 8; Ties: 23)

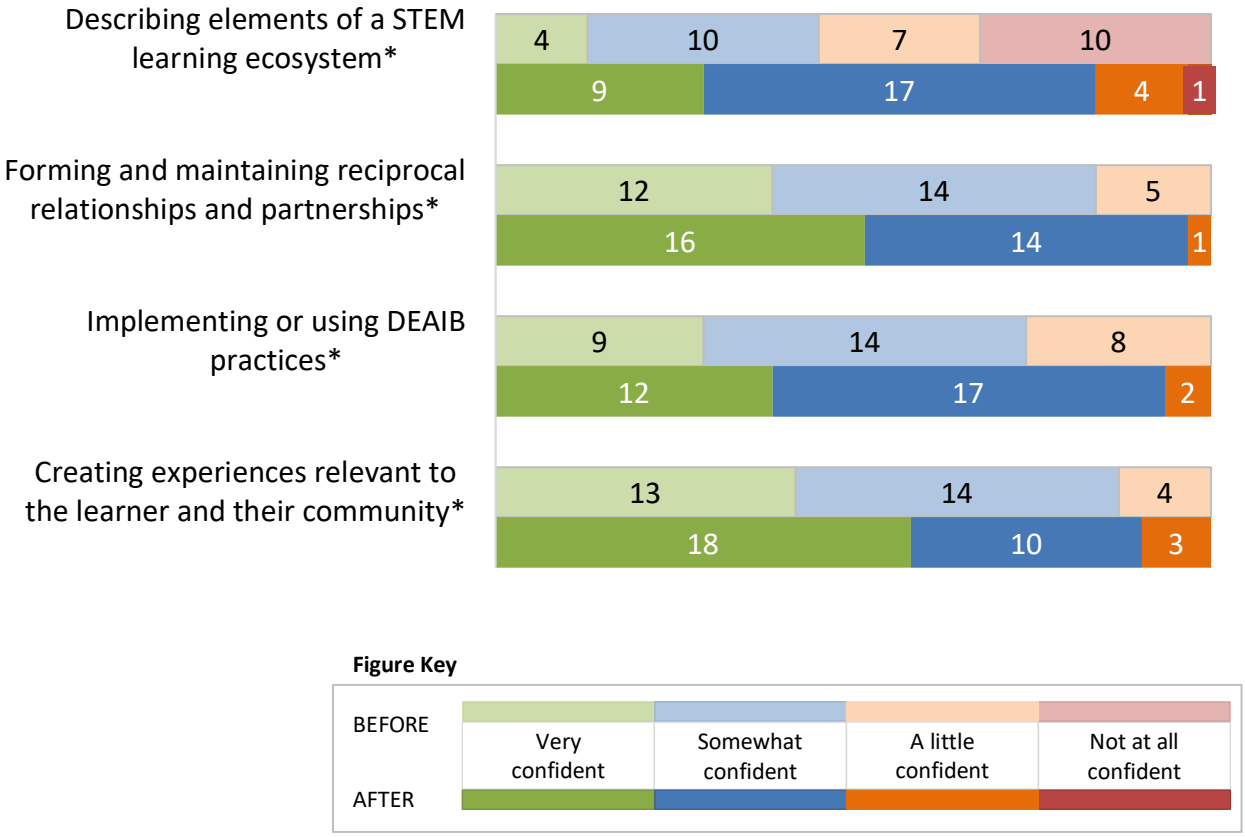
supported their learning including information about STEM learning ecosystems (6 of 22); hearing about ways to connect with communities to create authentic experiences (4 of 22); or learning about practices that support belonging (2 of 22). One attendee shared what they learned about STEM learning ecosystems, saying, *"I was not familiar with the STEM ecosystem concept, and I like that framework for thinking about and guiding the work that I do."* Finally, a few attendees (3 of 22) indicated that they learned something but left the meeting with more questions about STEM learning ecosystems, or that they were already knowledgeable so the meeting did not support learning about the topics for them (3 of 22 participants).

Figure 20. Open-ended responses to "Please explain what, if anything, about the meeting contributed to your understanding of these topics." (n=22)



Attendees were also asked a retrospective pre/post question about the change in their confidence to apply the principles and practices shared at the meeting. Similar to the finding above about understanding the topics, many attendees felt like they were better able to describe elements of a STEM learning ecosystem, with 26 (of 31) respondents reporting they were at least somewhat confident in their ability after the meeting. They also indicated that they were significantly more confident in their ability to put all of the practices discussed during the meeting into action, including forming and maintaining reciprocal relationships and partnerships, implementing practices related to belonging, and creating experiences relevant to the learner and their community, see Figure 21.

Figure 21. Please rate how confident you were in your ability to do the following things [BEFORE / AFTER] attending the Meeting (n=31)[10]



On an open-ended question asking participants to share what about the meeting contributed to their confidence, attendees most commonly (7 of 12) attributed their increased confidence to learning collaboratively with colleagues through discussions, with one person sharing that *"opportunities to discuss key findings gave me a better sense of that framework for working in STEM."* They also talked about practical examples that were shared during the meeting (3 of 12) and resources shared during the plenaries (2 of 12). Some attendees (4 of 12) mentioned that the meeting did not support increases in their confidence; however, they also noted that they were already confident in their abilities.

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[10] *Describing elements of a STEM learning ecosystem (Z= -3.802, p<0.001, Negative Ranks: 1; Positive Ranks: 19; Ties: 11)

*Forming and maintaining reciprocal relationships and partnerships (Z= -2.828, p=0.005, Negative Ranks: 0; Positive Ranks: 8; Ties: 23)

Implementing or using DEAIB practices* (Z= -2.714, p=0.007, Negative Ranks: 1; Positive Ranks: 10; Ties: 20)

Creating experiences relevant to the learner and their community* (Z= -2.121, p=0.034, Negative Ranks: 1; Positive Ranks: 7; Ties: 23)

4.1.4 Many attendees have used or plan to apply what they learned at the 2024 Tempe meeting to their own work.

Attendees were asked to reflect on meeting impacts approximately two months after the meeting in a follow-up survey. Most attendees (13 of 19) indicated that they had used or planned to use what they had learned during the meeting, with the rest (6 of 19) saying they were not sure. When asked to describe their use or plans for use, attendees typically described topics that connected to the principles and practices shared during the meeting. A few attendees (3 of 12) talked about sharing what they learned about the STEM learning ecosystem model. One attendee indicated that they were sharing their work through an ecosystem lens at an upcoming conference and had plans to *"encourage [partner organizations] to find/create an ecosystem in their communities."* Others (3 of 12) shared that they planned to focus on practices to support belonging. Attendees also planned to apply what they learned about creating relevant learning experiences (2 of 12) or planned on using the "What is Learning" cards (1 of 12). Some attendees (2 of 12) did not share specific information about what they planned to apply and instead talked generally about sharing information from the meeting.

Over half of participants (10 of 19) said they have not encountered any barriers to using what they learned, and 3 people said, *"I don't know."* The remaining attendees (6 of 19) indicated that they encountered barriers to using what they learned at the meeting. The main barrier identified by this group was finding time or capacity to incorporate new strategies (3 of 6). One person shared, *"The main challenge we have is workload, e.g., having time to think about how best to incorporate this into our work upon returning home."* With one response each, attendees also talked about the challenges to starting relationships, not being sure where to start, and forgetting details from the meeting.

4.2 STEM Learning Ecosystems and Community Partnership Meeting

The second in-person meeting, STEM Learning Ecosystems and Community Partnership Meeting or "2025 Saint Paul meeting," was held in August 2025 in Saint Paul, Minnesota. The meeting was focused on deepening the understanding of partnerships used to engage learners in Earth and space science, using the model of STEM learning ecosystems. Goals for the meeting were that participants would:

- Share and learn ways to create effective partnerships and engage learners in Earth and space science;
- Feel inspired and motivated by the resources and approaches shared during the meeting; and
- Build or strengthen connections with each other.

4.2.1 The 2025 Saint Paul meeting was an opportunity for teams from the NASA SciAct community to learn together with partners and community groups.

Over 100 people attended the meeting, representing a variety of NASA SciAct project teams and their organizational partners, along with the SciAct STEM Ecosystems team and project advisors. With the added emphasis on partnerships, invitees included professionals who were core team members for their SciAct project along with partners involved in their project's work. Excluding the SciAct STEM Ecosystems project team and advisors, 42 of 89 attendees responded to the post-event survey (46% response rate).

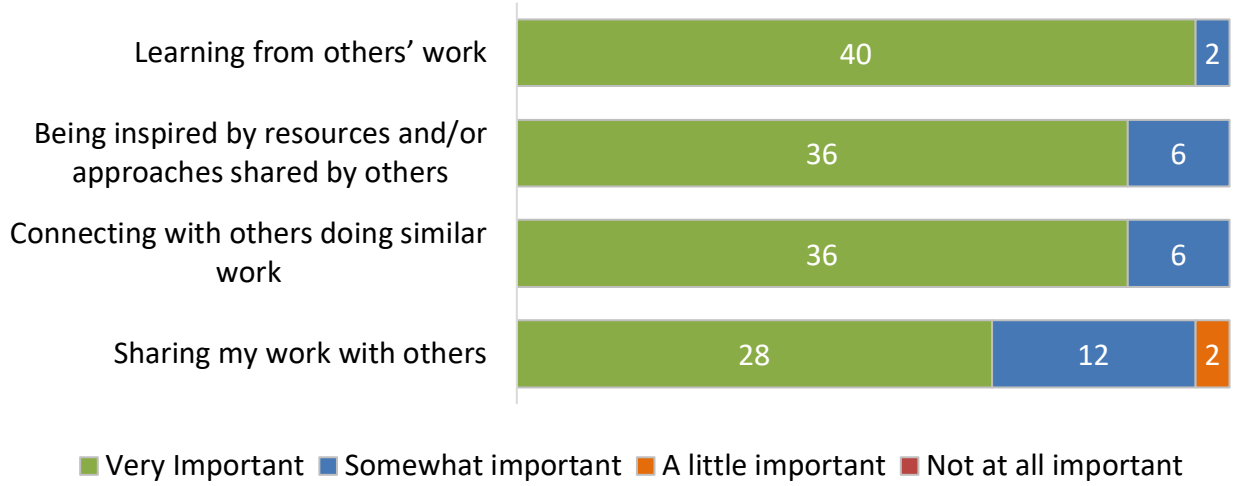
Attendees represented a variety of professional identities, with half selecting two or more roles. Most commonly, attendees indicated that they were engagement or outreach professionals (21 of 31), project administrators or project managers (19 of 31), or educators (18 of 31), see Figure 22. Most attendees reported they were experienced in partnering with other organizations for STEM engagement efforts, with 76% reporting 6 or more years of experience in this area.

Figure 22. How do you primarily identify as a professional with the project that you were representing at this meeting? (n=31)

4.2.2 Meeting attendees learned about new strategies and resources they could use to engage their audiences through the meeting.

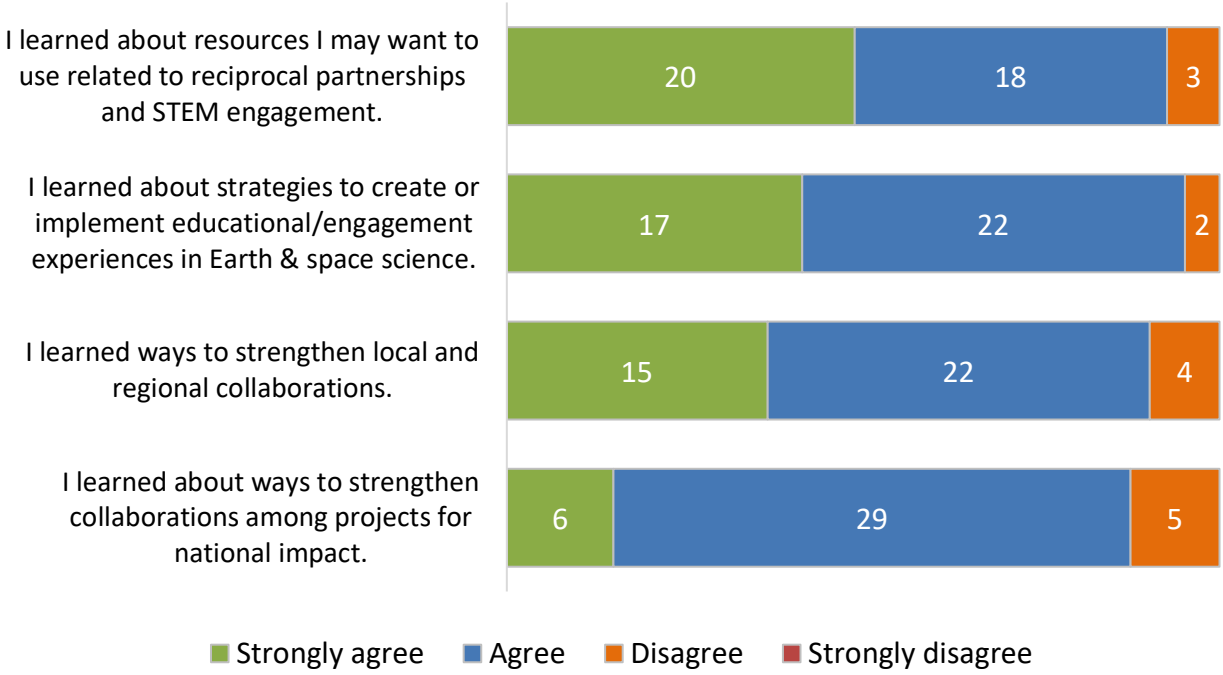
When asked through a closed-ended question, it was found that attendees' interests were aligned with the main meeting goals, with learning from others' work being very important to almost all attendees (40 of 42), see Figure 23. Most (36 of 42) also felt that being inspired by colleagues' work and connecting with others was very important. This finding was reinforced by high participation across the meeting, with 71% of participants reporting that they attended all scheduled sessions and activities. Those participants, who said they did not attend everything, said they only missed one concurrent session or plenary. Most participants also agreed that connecting with others doing similar work was very important to them (36 of 42) and that it was important to share their work with others (28 of 42).

Figure 23. How important are the following to you? (N=42)



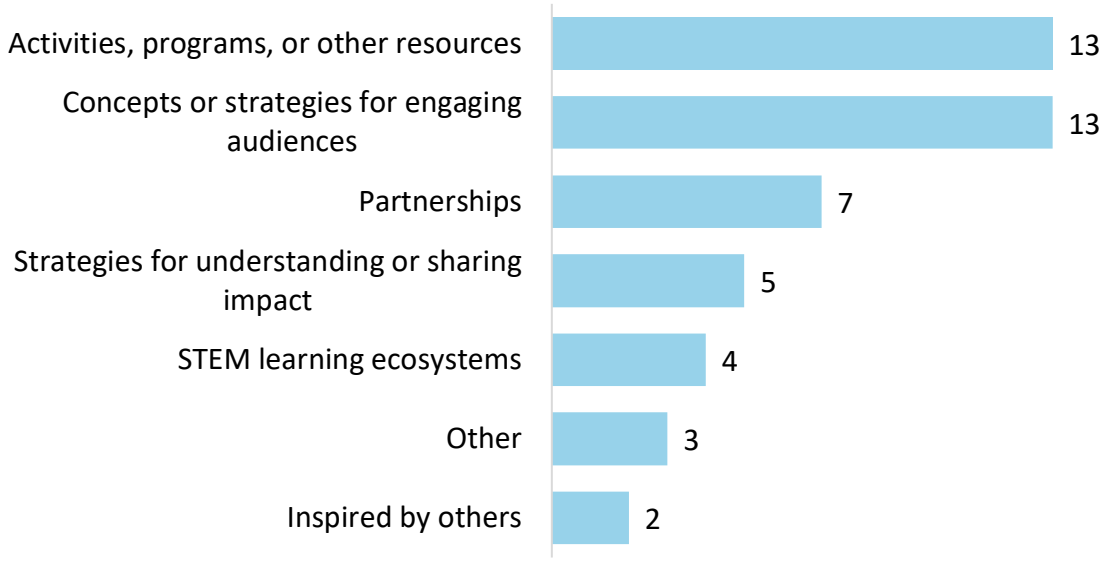
Almost all attendees felt that they learned something about resources related to reciprocal partnerships, strategies to implement engagement, ways to strengthen local collaborations, or wany to strengthen national collaborations. No attendees disagreed with all four statements, indicating that there was something new to learn for everyone. Half of the attendees (20 of 41) strongly agreed that they learned about resources they wanted to use related to reciprocal partnerships and STEM engagement, see Figure 24. Many strongly agreed that they were able to learn something about strategies for engaging audiences in Earth and space science (17 of 41) or ways to strengthen local collaborations (14 of 41). A few attendees (6 of 40) strongly agreed that they learned how to strengthen local connections for national impact, though many (29 of 40) agreed that they learned something in this area.

Figure 24. Because I attended the SciAct STEM Learning Ecosystems and Community Partnership Meeting. . . (n=41)



When asked in an open-ended question to share an example of something they learned during the meeting, attendees most commonly talked about new resources or strategies for engaging audiences, see Figure 25. Attendees (13 of 35) learned about activities, programs, or other resources, specifically referencing other SciAct projects, such as GLOBE, NASA at My Library, NISE Network, and Space Telescope Science Institute. Some of these attendees spoke more generally about the resources they learned about, suggesting that they learned about resources from multiple projects. One of these respondents said, *"I learned about a wide range of resources (publications, activities, and organizations) that I could utilize or connect with that would enrich or expand current programs or inform how we think about co-creation practices."* Other attendees (13 of 35) shared that they learned about strategies for engaging audiences, often referring to specific concepts related to belonging, ways of knowing, or building connections and partnerships. One attendee reported, *"I learned about ways to thoughtfully nurture a sense of belonging. I learned about ways to engage rural audiences."* A smaller number of attendees said that the meeting allowed them to learn about or reinforce knowledge about: partnering with others (7 of 35), strategies for understanding or sharing impact (5 of 35), and STEM learning ecosystems (4 of 35).

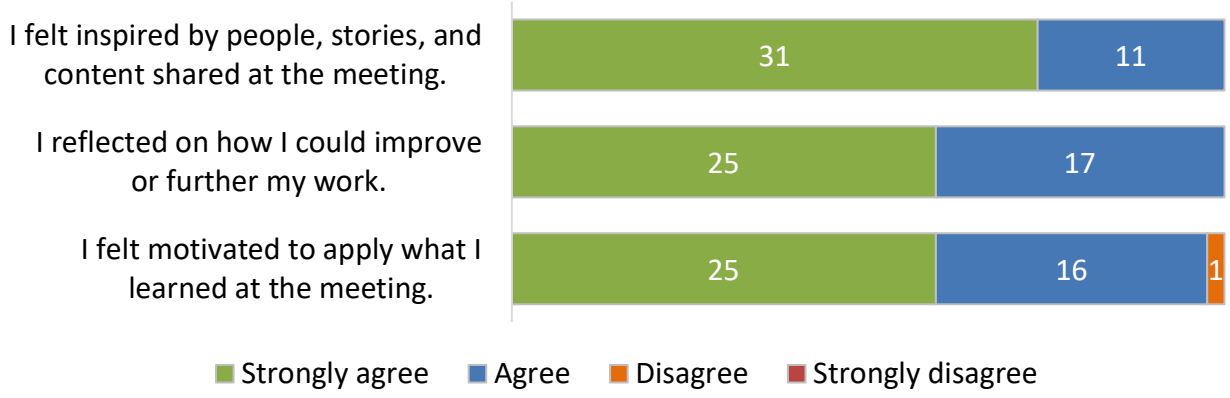
Figure 25. Open-ended responses to "Please share an example of something you learned from the presenters or other attendees at the meeting." (n=35)



4.2.3 The 2025 Saint Paul meeting provided an opportunity for attendees to feel inspired by others, and they planned to apply what they learned to their own work.

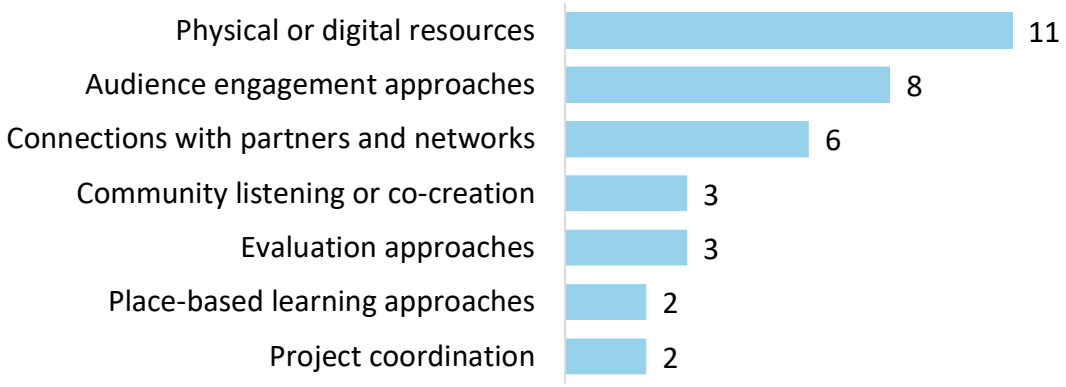
Almost all 2025 Saint Paul meeting attendees felt inspired, reflective, or motivated in their work because they attended the meeting. Most attendees (31 of 42) strongly agreed that they were inspired by people, stories, and content shared at the meeting, see Figure 26. Over half of the attendees also strongly agreed they were able to reflect on changes they could implement in their own work because of the meeting (25 of 42), or were motivated to apply what they learned (25 of 42).

Figure 26. Because I attended the SciAct STEM Learning Ecosystems and Community Partnership Meeting. . . (N=42)



In the follow-up open-ended question, attendees shared a variety of ways that they were interested in using or adapting what they learned after the meeting (see Figure 27). Attendees most often (11 of 33) shared physical or digital resources they were interested in using or adapting for their work, such as GLOBE resources, library kits, the NISE Network activity "What Values Do You Share?", and more. They were also interested in applying what they learned about approaches for engaging audiences (8 of 33). One person shared, "*[I learned about] the difference between engagement and immersion when it comes to involving students in 'authentic' ways.*" Some attendees (6 of 33) also talked about leaning into connections with partners and networks in their local communities or STEM learning ecosystems. One of these said they were interested in "*inviting potential partners to a meeting to share their (and their organizations') values and goals, as a starting place for creating a local STEM network.*"

Figure 27. Open-ended responses to "Please share one thing you learned or discussed at the meeting that you are interested in using or adapting in your own work." (n=33)



While most attendees identified a variety of resources and strategies that they were interested in using or adapting in their own work, they also recognized that there may be barriers to applying what they learned during the meeting. In response to an open-ended question, attendees anticipated that barriers would be related to available funding (14 of 31) or time (10 of 31), with some calling attention to the overlap between these categories (Figure 28). One of these participants provided details about how time could be a barrier, saying:

> *"One is time to delve into all the resources that I collected and share them with my team to inspire ways to integrate these ideas into our existing or current work. This is a process that requires planning to review, brainstorm and follow through that can be difficult with the many other duties I have."*

Beyond these ever-present concerns, some attendees anticipated barriers related to finding, starting, or maintaining relationships (5 of 31), with one person saying, "*I am not connected to partners at the level that will make it easy to use these learnings.*" Beyond these concerns, some talked about concerns around aligning perspectives between partners or audiences (4 of 31). Others mentioned personnel expertise concerns (2 of 31), such as having staff available with the skills needed, having organizational

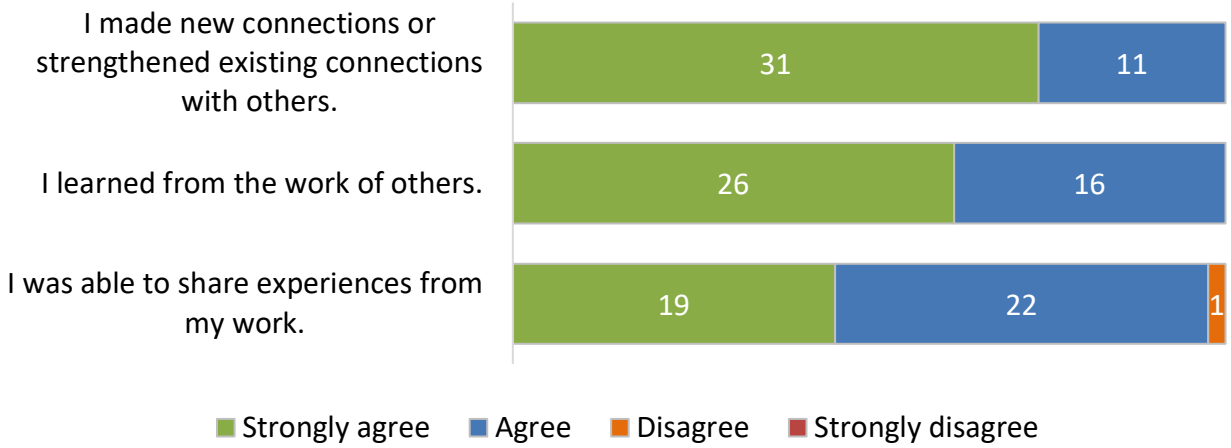
support (2 of 31), and understanding how to share locally-developed experiences across the varied contexts (2 of 31).

Figure 28. Open-ended responses to "What barriers and/or challenges do you anticipate in using or adapting learnings from the meeting in your own work?" (n=31)

4.2.4 Attendees felt connected to others doing similar work, attributing this to specific activities and formats during the meeting.

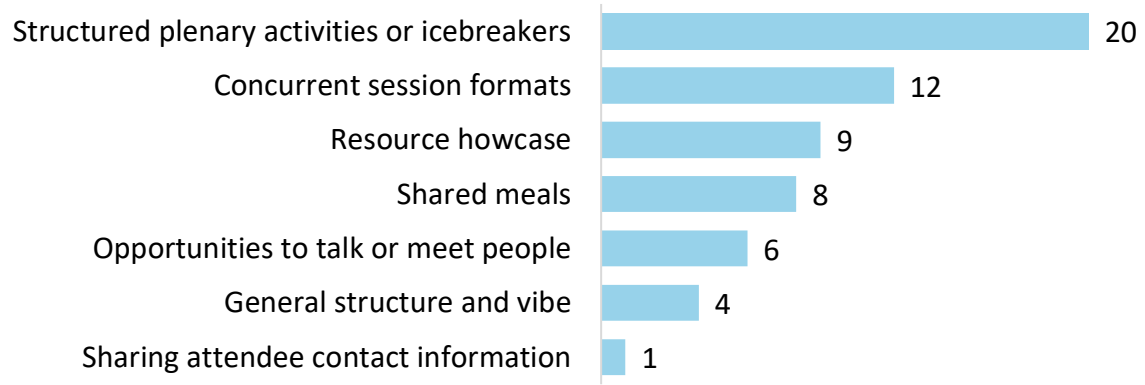
The 2025 Saint Paul meeting provided many opportunities for attendees to connect with each other. Many attendees (31 of 42) strongly agreed they made new connections or strengthened existing connections at the meeting, Figure 29. Nearly all respondents agreed they learned from others (42 of 42) and shared their own experiences (41 of 42).

Figure 29. "Through participation in the SciAct STEM Learning Ecosystems and Community Partnership Meeting… (n=42)



On an open-ended follow-up question, most attendees (20 of 37) indicated that the structured activities and icebreakers during the plenary sessions supported making and strengthening connections with others. They referred to these activities generally, emphasizing that the format of getting up to move around and talk to new people was important. As one attendee explained, "*The team building-style exercises, especially having to get up and move to interact with people outside of the tables I sat at [supported me in making and strengthening connections].*" Additionally, some attendees (12 of 37) said that the concurrent sessions, which shared information through a variety of formats such as panel presentations, discussions, or art-based activities, provided opportunities for them to connect with others, see Figure 30. One person noted that the interactive format helped them make connections, saying "*The sessions were very interactive and fostered talking about our approaches.*" Another attendee noted the variety of speakers saying, *"Just hearing from all the different groups about their approaches to working with their communities [helped me make connections]."* Attendees noted that other opportunities for building connections during the meeting included the showcase of resources (9 of 37) and ample time to talk with others during meals, breaks, and other times (6 of 37).

Figure 30. Open-ended responses to "What aspects of the meeting supported making new connections or strengthening existing connections with other teams/projects?" (n=37)



Beyond talking about the aspects of the meeting that supported connections, attendees were also asked for feedback about how the team could support them in making new connections or strengthening existing ones. In response to this open-ended question, many attendees' suggestions implied that the meeting provided a good foundation for connecting with others, typically requesting more of what the meeting provided. Attendees suggested including additional strategies for facilitating introductions (7 of 30), such as speed dating-style introductions, connecting people doing similar work, or sharing attendee bios (Figure 31). They also talked about ways they wanted to have support for continuing what was started during the meeting, such as providing ways for ongoing connections between attendees (6 of 30), sharing updates or new resources from attendees (6 of 30), or continuing to hold this type of in-person meeting (4 of 30).

Figure 31. Open-ended responses to "What could we do to support making new connections or strengthening existing connections with other teams/projects?" (n=30)

5. Discussion

5.1 Summary of findings

Overall, data collected across the summative evaluation suggests that the SciAct STEM Ecosystems project team was successful at planning and implementing professional learning experiences. Webinars provided broad access, attracting people representing a variety of professional roles, often including educators and STEM outreach professionals. Both the NASA SciAct community and NISE Network webinars were focused on introducing the STEM learning ecosystem model and sharing key ideas from the inquiry study. Many attendees at the NASA SciAct community webinar were interested in reflecting on or learning more about the STEM learning ecosystem model, along with learning more about specific approaches to support belonging. Attendees at the NISE Network webinars were interested in applying what they learned by connecting with partners and local ecosystems.

In-person meetings allowed for deeper learning and building connections with peers doing similar work. At the 2024 Tempe meeting, practices related to belonging, partnering, and creating authentic learning experiences were relevant to attendees, while at the 2025 Saint Paul meeting, attendees learned about new strategies and resources they could use to engage audiences. After the 2024 Tempe meeting, attendees felt more confident that they understood elements of STEM learning ecosystems and more confident in their ability to apply practices related to belonging, partnering, and authentic STEM learning experiences in their own work. A couple months after the 2024 Tempe meeting, attendees reported that they had already started to apply what they learned or had plans to do so. Both in-person meetings fostered connections between attendees that were important for their learning.

5.2 Webinars and in-person meetings sparked attendees' interest and intent to apply what they learned to their own work.

Webinars and in-person meetings were able to build energy and intent among participants to integrate new resources or approaches into their work. The shorter professional development format was primarily used to introduce attendees to the STEM learning ecosystem model and key ideas. These online offerings afforded broad access to the content and allowed attendees to begin considering which practices they could integrate into their own work. Webinar attendees were most often interested in learning more about topics such as specific approaches to support belonging or the STEM learning ecosystem model. These findings indicate that similar webinars can be used to share ideas and start conversations that support deeper learning. In-person meetings similarly stimulated interest in the principles and practices highlighted in the meetings, such as the key ideas. Additionally, during concurrent sessions, projects doing similar work could share more detailed examples than they were able to do during the webinars, which offered attendees more ideas on how to incorporate these principles in their own work. After the 2025 Saint Paul meeting, attendees were most commonly interested in using the resources or audience engagement approaches they learned about. Together, these findings show that short online experiences and longer in-person meetings can provide an introduction to a topic and spark interest in learning more on their own time.

5.3 In-person meetings offered opportunities for connection between colleagues and collaborative learning.

Multi-day in-person meetings offered opportunities for more measurable impacts across a small group of people. These in-depth experiences supported attendees' ability to build connections, learn about new principles or practices, and increase their confidence to integrate new resources or approaches into their work. The variety of opportunities to learn and engage with others meant that attendees of in-person meetings could find something that worked for them, as survey responses indicated that multiple formats of sharing information were effective for attendees. In particular, convening in-person and learning together offered opportunities for attendees to make connections with colleagues. They were able to discuss specific approaches that had worked for them and be inspired by others' work. When they described what they learned, attendees often shared very specific examples of a resource, tool, or approach, that resonated with their work. These findings indicate that in-person meetings can provide opportunities for connection and collaborative learning that can influence attendees' practices by providing an array of approaches to try in their own work.

6. Conclusion

The SciAct STEM Ecosystems project supported sharing and learning across the NASA Science Activation portfolio and leveraged external partners to expand the reach beyond NASA Science Activation teams.

The SciAct STEM Ecosystems project aimed to address two NASA SciAct mid-level objectives (MLOs) related to professional learning across and beyond the portfolio. All project activities supported MLO 4a: leveraging internal mechanisms to support sharing and learning across the NASA SciAct portfolio. Utilizing the NISE Network to host webinars and share digital materials supported MLO 4b: utilizing external partners to leverage the reach and effectiveness of the NASA SciAct portfolio. Overall, the project provided opportunities for professionals to learn from each other about practices and resources that support broadening participation in Earth and space science through authentic learning experiences.

The inquiry study that produced the key ideas shared at webinars and in-person meetings was developed in collaboration with three established NASA SciAct projects. Together these teams generated findings, or key ideas, so that others could learn from their experience using the STEM learning ecosystem model to engage audiences in Earth and space science. Webinars and in-person meeting attendees intentionally included team members from current NASA SciAct projects and their partners. In alignment with the SciAct STEM Ecosystems project, learnings shared by these additional NASA SciAct projects typically addressed efforts to broaden participation in NASA STEM and develop products and resources for public engagement. The professional learning opportunities were developed first and foremost to share the key ideas. They also provided opportunities to connect with colleagues to support collaborative learning, share knowledge across projects, and support attendees' intent and ability to apply what they learned to their own work. Speakers for concurrent sessions at in-person meetings were recruited from active NASA SciAct projects to share what they had learned, as well as the available resources from their projects. This created opportunities for people to learn about other projects and further spread knowledge across the NASA SciAct community. Finally, the in-person meetings included a showcase that highlighted resources from projects across the NASA SciAct portfolio.

Since the content shared with meeting attendees was largely grounded in other NASA SciAct projects' work, evidence of learning from the evaluation demonstrates that the project supported sharing and learning across the NASA SciAct portfolio. Findings about the webinars and in-person meetings indicate that attendees not only learned from colleagues across the portfolio, but that they also intended to apply the practices or use the resources they learned about. Making space to gather, whether virtually at shorter webinars or through multi-day in-person meetings, facilitated sharing practices and resources from a variety of projects and perspectives. At these gatherings, attendees were able to learn from many voices, participate in a variety of professional development and networking formats, and learn about practices and resources. Together, these opportunities encouraged attendees to apply that they learned or to use resources from other NASA SciAct projects. Gatherings helped participants not only learn about other NASA SciAct teams' approaches, results, and resources, but also get ideas on how to apply them in their own work.

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Appendix A: Instruments

Included in this appendix is a representative selection of the instruments used in the SciAct STEM Ecosystems Summative Evaluation.

2024 Tempe meeting – Post-event survey
Note: These data were collected in 2024 and may not reflect current policy or program focus

Tell us about yourself:

1. How do you primarily identify as a professional with the project that you were representing at this meeting? Please select all that apply.

- Educator
- Scientist or subject matter expert
- Community organizer
- Engagement or outreach professional
- Evaluator or learning researcher
- Program or content developer
- Project administrator or project manager
- Other (please describe): _____

2. How long have you been involved with the NASA SciAct program?

- Less than 1 year
- 1-2 years
- 3-5 years
- 6 or more years
- I am not involved in the NASA SciAct program.

3. How involved/active with the NASA SciAct program are you in your day-to-day work?

- I am very involved.
- I am involved a little.
- I am not involved.

4. Please rate how much you agree or disagree with the following statements:

	Strongly disagree	Disagree	Agree	Strongly agree
STEM learning ecosystems are new to me.				
My work/project uses elements of STEM learning ecosystems.				
My work/project supports STEM learning ecosystems.				
My work/project is directly involved in STEM learning ecosystems.				

Tell us what you did at the meeting:

5. Which plenary sessions or activities did you attend during the meeting?

- Visiting the Arizona Science Center (Day 1 dinner event)
- Plenary sessions and table discussions (Days 2-3)
- Night Sky Viewing (Day 2)
- Networking and social activities (e.g., meals, cross-collaboration time) (Days 2-3)
- Other (please describe): _____
- None of the above / I don't remember

6. Which concurrent sessions did you attend on Day 2 (Wednesday, January 17)? Please select all that apply.

- Broadening participation in STEM: Diversity, equity, accessibility, inclusion, and belonging (DEAIB) principles and practices
- Connecting and collaborating with existing STEM Learning Ecosystems across the US
- Cultural Roots of STEM
- Putting NASA assets and SciAct resources into practice (examples from Earth science projects)
- Putting NASA assets and SciAct resources into practice (examples from astronomy projects)
- Strategies for building and maintaining relationships with people and organizations
- Incorporating citizen and community science in STEM learning experiences
- Educator professional development examples and strategies for formal and informal educators
- None of the above / I don't remember

7. Which concurrent sessions did you attend on Day 3 (Thursday, January 18)? Please select all that apply

- Strategies and experiences collaborating with Indigenous communities
- Centering place-based, data fluency using NASA assets
- Evaluating impacts of Community Collaborations
- Workshop on co-creating STEM engagement and learning experiences
- Nuts and bolts of forming and sustaining a place-based learning ecosystem
- Discussion tables focusing on solutions and challenges of practice(e.g., cultivating a sense of belonging, co-creation and community relationships, place-based content, developing equitable partnerships, community and citizen science, making STEM relevant)
- Project advisor meeting (by invitation only)
- None of the above / I don't remember

Understanding STEM learning ecosystems

8. Please rate how confident you were in your understanding of the following topics BEFORE attending the *SciAct STEM Learning Ecosystems* Meeting.

	Not at all confident	A little confident	Somewhat confident	Very confident
Describing a STEM learning ecosystem (e.g., structures, purposes, partners)				
Forming and maintaining reciprocal relationships and partnerships				
Centering Diversity, Equity, Access, Inclusion, and Belonging (DEAIB) practices (e.g., working in ways that value people and cultures)				
Creating experiences relevant to the learner and their community (e.g., supporting authentic STEM engagement)				

9. Please rate how confident you are now in your understanding of the following topics AFTER the SciAct STEM Learning Ecosystems Meeting.

	Not at all confident	A little confident	Somewhat confident	Very confident
Describing a STEM learning ecosystem (e.g., structures, purposes, partners)				
Forming and maintaining reciprocal relationships and partnerships				
Centering Diversity, Equity, Access, Inclusion, and Belonging (DEAIB) practices (e.g., working in ways that value people and cultures)				
Creating experiences relevant to the learner and their community (e.g., supporting authentic STEM engagement)				

10. Please explain what, if anything, about the meeting contributed to your understanding of these topics.

Confidence in using practices

11. Please rate how confident you were in your ability to do the following things BEFORE attending the SciAct STEM Learning Ecosystems Meeting.

	Not at all confident	A little confident	Somewhat confident	Very confident
Describing a STEM learning ecosystem (e.g., structures, purposes, partners)				
Forming and maintaining reciprocal relationships and partnerships				
Centering Diversity, Equity, Access, Inclusion, and Belonging (DEAIB) practices (e.g., working in ways that value people and cultures)				
Creating experiences relevant to the learner and their community (e.g., supporting authentic STEM engagement)				

12. Please rate how confident you are now in your ability to do the following things AFTER the SciAct STEM Learning Ecosystems Meeting.

	Not at all confident	A little confident	Somewhat confident	Very confident
Describing a STEM learning ecosystem (e.g., structures, purposes, partners)				
Forming and maintaining reciprocal relationships and partnerships				
Centering Diversity, Equity, Access, Inclusion, and Belonging (DEAIB) practices (e.g., working in ways that value people and cultures)				
Creating experiences relevant to the learner and their community (e.g., supporting authentic STEM engagement)				

13. Please explain what, if anything, about the meeting contributed to your confidence in your ability to do these things.

14. How related are the following topics from the SciAct STEM Learning Ecosystems Meeting to your work in SciAct or beyond?

	Not at all relevant	A little relevant	Somewhat relevant	Very relevant
Describing a STEM learning ecosystem (e.g., structures, purposes, partners)				
Forming and maintaining reciprocal relationships and partnerships				
Centering Diversity, Equity, Access, Inclusion, and Belonging (DEAIB) practices (e.g., working in ways that value people and cultures)				
Creating experiences relevant to the learner and their community (e.g., supporting authentic STEM engagement)				

15. [Show if "somewhat" or "very" related selected for any item in Q14.] Please describe how these topics relate to your work.

16. [Show if "not at all" or "a little" related selected for any item in Q14.] Please describe why these topics felt disconnected from your work. This could include barriers and challenges.

Connections in the NASA SciAct community

17. Please rate your agreement with the following statements. "Through participating in the SciAct STEM Learning Ecosystems Meeting, I…"

	Strongly disagree	Disagree	Agree	Strongly agree
Learned from other NASA SciAct teams/projects.				
Was able to share experiences from my NASA SciAct project(s) or other work.				
Made new connections or strengthened existing connections with other NASA SciAct teams/projects.				
Feel more connected with other NASA SciAct teams/projects.				
Had an opportunity to reflect on my own work in new ways.				

17. Please share an example of one thing you reflected on or learned from the presenters or other attendees at the meeting.

Note: The survey also contained questions for the formative evaluation to guide the development of future project offerings. Since these data are not addressed in the summative evaluation, that section of the survey has been omitted.

2024 Tempe meeting – Two-month follow-up survey

1. How do you primarily identify as a professional with the project that you were representing at this meeting? Please select all that apply.

- Educator
- Scientist or subject matter expert
- Community organizer
- Engagement or outreach professional
- Evaluator or learning researcher
- Program or content developer
- Project administrator or project manager
- Other (please describe): _____

2. How long have you been involved with the NASA SciAct program?

- Less than 1 year
- 1-2 years
- 3-5 years
- 6 or more years
- I am not involved in the NASA SciAct program.

3. How involved/active with the NASA SciAct program are you in your day-to-day work?

- I am very involved.
- I am involved a little.
- I am not involved.

4. Have you encountered/Are you encountering barriers or challenges to using what you learned in your work?

- Yes
- No
- I don't know

5. [Show if "yes" in Q4] Please describe the barriers or challenges you have encountered.

6. We would also like to understand how participating in the meeting affected your connection to the NASA SciAct community. This could include new or strengthened connections with other NASA SciAct teams or projects.

What aspects of the meeting supported making new connections or strengthening existing connections with other teams/projects?

7. Thinking about things you reflected on or learned from other attendees at the meeting. Have you followed up on something you reflected on or learned from other attendees? This could include both current or future work, both in SciAct and beyond.

- Yes
- No
- I don't know

8. Please share an example of how you followed up or took action on something you reflected on or learned from other attendees at the meeting.

9. Are there any additional comments or feedback you would like to share?

2025 Saint Paul meeting – Post-event survey

1. How do you primarily identify as a professional with the project that you were representing at this meeting? Please select all that apply.

- Educator
- Scientist or subject matter expert
- Community organizer
- Engagement or outreach professional
- Evaluator or learning researcher
- Program or content developer
- Project administrator or project manager
- Other (please describe): _____

2. How long have you been involved in partnering with other organizations around STEM engagement?

- Less than 1 year
- 1-2 years
- 3-5 years
- 6 or more years
- I am not involved in the NASA SciAct program.

3. How long have you been involved in partnering with other organizations around STEM engagement?

	Not at all important	A little important	Somewhat important	Very important
Sharing my work with others				
Learning from others' work				
Being inspired by resources and/or approaches shared by others				
Connecting with others doing similar work				

4. What did you attend during the meeting?

- 5:00 pm | Plenary, dinner, and networking activities
- 9:00 am | Presentation and activity at tables
- 12:00 pm | Lunch, presentation, and activity at tables
- 10:30 am | Concurrent Sessions A
- 1:30 pm | Concurrent Sessions B
- 3:00 pm | Presentation, and breakout activities
- 10:45 am | Concurrent Sessions C
- 12:00 pm | Lunch, presentations, and reflections
- 1:00 pm | Project Advisors meeting (invitation only)

5. Which concurrent sessions did you attend during the meeting? Please select all that apply.

[Show if selected in Q4] Concurrent Session A (Tuesday Morning)

- Co-creating STEM engagement and learning experiences, refining your co-creation practices (Group 1)
- Strategies for engaging rural communities
- Tools for community listening and conversations
- Planning, building, and maintaining reciprocal and sustainable partnerships
- Community Festivals and Celebrations - value and impact of community partnerships
- None of the above / I don't remember

[Show if selected in Q4] Concurrent Session B (Tuesday Afternoon)

- How do you know your community partnerships are working? Evaluation to the rescue!
- Authentic STEM learning with NASA assets
- The intersection of art and science: community art projects, murals, and cultural relevance
- Collaborating with libraries
- None of the above / I don't remember

[Show if selected in Q4] Concurrent Session C (Wednesday Morning)

- Co-creating STEM engagement and learning experiences, refining your co-creation practices (Group 2 sharing)
- Strategies for engaging all learners
- Incorporating citizen and community science in STEM learning experiences
- Belonging and mentorship for future Earth and space scientists
- None of the above / I don't remember

6. Please rate your agreement with the following statements. “During the SciAct STEM Learning Ecosystems and Community Partnership Meeting . . .”

	Strongly disagree	Disagree	Agree	Strongly agree
I learned ways to strengthen local and regional collaborations.				
I learned about ways to strengthen collaborations among projects for national impact.				
I learned about strategies to create or implement educational/engagement experiences in Earth & space science.				
I learned about resources I may want to use related to reciprocal partnerships and STEM engagement.				

7. [Show if “agree” or “strongly agree” is selected for any item in Q6] Please share an example of something you learned from the presenters or other attendees at the meeting.

8. [Show if “agree” and “strongly agree” is **not** selected for any item in Q6] What could we have done to improve your learning experience?

9. Please rate your agreement with the following statements. "During the SciAct STEM Learning Ecosystems and Community Partnership Meeting . . ."

	Strongly disagree	Disagree	Agree	Strongly agree
I reflected on how I could improve or further my work.				
I felt inspired by people, stories, and content shared at the meeting.				
I felt motivated to apply what I learned at the meeting.				

10. Please share one thing you learned or discussed at the meeting that you are interested in **using or adapting in your own work.**

11. What **barriers and/or challenges** do you anticipate in using or adapting learnings from the meeting in your own work?

12. Please rate your agreement with the following statements. "During the SciAct STEM Learning Ecosystems and Community Partnership Meeting . . ."

	Strongly disagree	Disagree	Agree	Strongly agree
I learned from the work of others.				
I was able to share experiences from my work.				
I made new connections or strengthened existing connections with others.				

13. What **aspects of the meeting** supported making new connections or strengthening existing connections with other teams/projects?

14. What could we do to support making new connections or strengthening existing connections with other teams/projects?

15. **Additional comments or feedback about the meeting:** What did you like and / or not like about it? Share your concerns and your great ideas!

2024 NASA SciAct community webinar – Meeting polls and reflection prompts

1. How do you primarily identify as a professional with the project that you were representing at this meeting? Please select all that apply.

- Educator
- Scientist or subject matter expert
- Community organizer
- Engagement or outreach professional
- Evaluator or learning researcher
- Program or content developer
- Project administrator or project manager
- Other

2. How involved are you with a NASA SciAct program in your day-to-day work?

- I am very involved.
- I am involved a little.
- I am not involved.

3. Which statement(s) best describe your familiarity with principles and practices of STEM learning ecosystems? Please select all that apply.

- STEM learning ecosystems are new to me.
- My work/project uses aspects of STEM learning ecosystems.
- My work/project supports STEM learning ecosystems.
- My work/project is directly involved in STEM learning ecosystems.

4. Which topics about STEM learning ecosystems are related to your work in SciAct and beyond? Please select all that apply.

- Structure and elements of a STEM learning ecosystem
- Reciprocal relationships and partnerships
- Diversity, Equity, Access, Inclusion, and Belonging (DEAIB) practices
- Learning experiences relevant to learners and their community

5. Spend a moment reflecting, then share your thoughts in the chat. You can answer one of these questions, or add an idea of your own:

- What is something from today's meeting that you're interested in following up on?
- Does the concept of STEM learning ecosystems resonate with you in any new ways? How?

2025 NISE Network webinars – Meeting polls and reflection prompts

1. How do you identify as a professional within the project that you are representing today?

- Educator
- Scientist or subject matter expert
- Community organizer
- Engagement or outreach professional
- Evaluator or learning researcher
- Program or content developer
- Project administrator or project manager
- Other

2. Which statement best describes your familiarity and involvement with STEM learning ecosystems?

- STEM learning ecosystems are new to me.
- My work/projects aren't part of a STEM learning ecosystem, but I'm familiar with them
- My work/project uses practices from STEM learning ecosystems
- My work/project supports STEM learning ecosystems.
- My work/project is directly involved with STEM learning ecosystems.

3. Spend a moment reflecting, then share your thoughts in the chat. You can answer one of these questions, or add an idea of your own:

- What is something from today's meeting that you're interested in following up on?
- Does the concept of STEM learning ecosystems resonate with you in any new ways? How?