NASA SciAct STEM Ecosystems to Broaden Participation in Authentic STEM Learning

STEM LEARNING ECOSYSTEMS

Defining STEM Ecosystems within NASA

STEM Ecosystems Community of Practice (SLECoP)
Bay City MI June 21, 2022

ASU
Center for Innovation in Informal STEM Learning
Arizona State University

Arctic & Earth STEM Integrating Globe & NASA

Learning Ecosystems Northeast

Gulf of Maine Research Institute

RAIN rural activation and innovation network

Smoky Mountains STEM Collaborative

NASA Science Activation
STEM Learning Ecosystems Project

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Think/Pair/Share

- On a post it note - please give three bullet point definitions of RURAL.
- Share with your table and come up with three shared definitions.
- Appoint a speaker for your group - share the table consensus items.

STEM LEARNING ECOSYSTEMS

RAIN
rural activation and innovation network

NASA Partner

A. NASA Science Activation STEM Learning Ecosystems Project

B. Ecosystem in Action Study

C. NASA Resources You Can Use

Activity Prep

Please download the following App and register:

GLOBE OBSERVER

NASA SciAct STEM Ecosystems Team

Connecting Subject Matter Experts, Communities, and Learners of All Ages

STEM LEARNING ECOSYSTEMS

INVESTIGATORS:
Rae Ostman, Arizona State University (PI)
Matthew Cass, Southwestern Community College (co-I)
Paul Martin, Arizona State University (co-I)
Elena Sparrow, University of Alaska Fairbanks (co-I)

CORE TEAM MEMBERS:
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Ali Jackson, Sciencenter Ithaca, NY
Kalman Mannis, Arizona Science Center, Phoenix, AZ
Catherine McCarthy, Arizona State University, Tempe, AZ
Randi Neff, Southwestern Community College, Sylva, NC

EVALUATORS:
Liz Kollmann (lead) and Allison Anderson, Museum of Science Boston
Katrina Bledsoe, Abt Associates

Major project activities

- Complete an ***inquiry series*** that synthesizes evidence for principles and practices of learning ecosystems that broaden participation in authentic STEM engagement;
- ***Implement, document, and study exemplary ecosystems*** that leverage NASA's unique assets, stories, and people;
- ***Provide professional development and resources*** to NASA SciAct teams related to STEM ecosystem principles and practices to support SciAct goals; and
- ***Facilitate dissemination and sustainability of project findings***, resources, and approaches among professionals who are active in STEM engagement and education.

STEM LEARNING ECOSYSTEMS

Gathering information

Ecosystem Focus Groups + Advisors

- Arctic & Earth STEM Integrating GLOBE & NASA (SIGNs)
- Learning Ecosystems Northeast / GMRI
- Rural Activation and Innovation Network (RAIN)
- Smoky Mountains STEM Collaborative (SMSC)

STEM LEARNING ECOSYSTEMS

Gathering information

Focus groups and interviews took place in **Spring 2021 and Spring of 2022**

Conversations focused on:

- Describing project background / professional knowledge
- Reviewing existing definitions of STEM learning ecosystems and suggesting changes based on lived experiences
- Identifying attributes or key aspects of STEM learning ecosystems to attend to
- Reacting to examples from literature about important aspects of STEM learning ecosystems
- Reflecting on value or purpose of STEM learning ecosystems

STEM LEARNING ECOSYSTEMS

Analyzing the data

Process

- Review each case and summarize the main themes
- Look across cases for similarities and differences

Coding themes

- Descriptions of the ecosystem
  - What is the culture/context each project is working within?
- Definitions for ecosystems
  - How do responses align with existing literature?
  - How do they differ from existing literature?
  - How should / are groups using STEM learning ecosystems as a model?
- Aspects of ecosystems
  - How do ecosystems attend to eight “critical factors” -- ‘partnerships, leadership, pathways, educator capacity, mission, community, STEM literacy, and interest’, (Vance et al., 2016)?
  - How do ecosystems attend to sustainability, productivity, resilience (Falk et al., 2020)?
- Strengths/challenges

STEM LEARNING ECOSYSTEMS

Initial Working definition

STEM learning ecosystems unite people, groups, and resources to create STEM engagement and education experiences for all people throughout their lifetimes.

By developing mutually beneficial partnerships, leveraging complementary expertise and resources, implementing best practices, and creating pathways among learning opportunities, STEM ecosystems can support individual learning and community growth.

STEM LEARNING ECOSYSTEMS

Literature focus for Working definition

A STEM learning ecosystem (in no particular order):

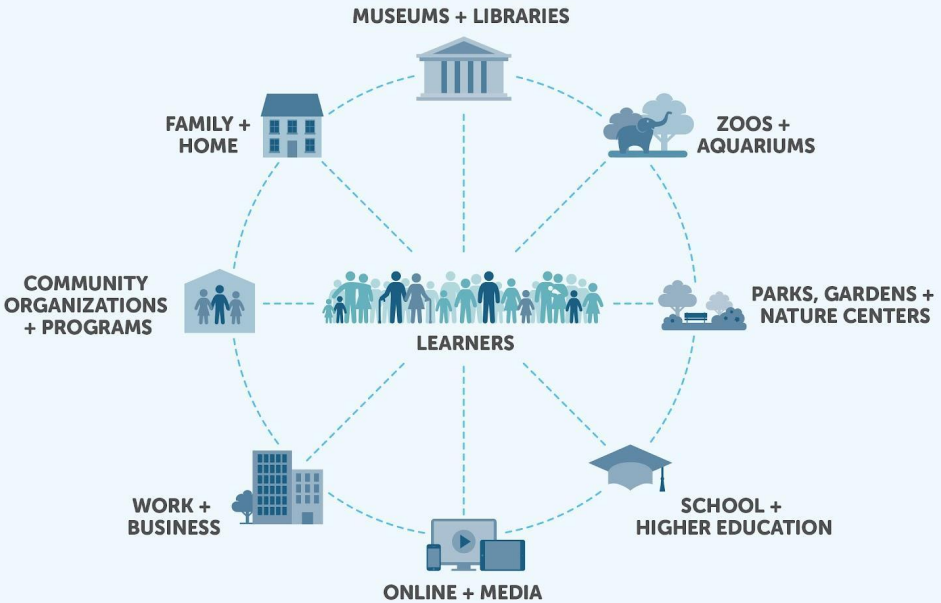
- Involves **many different organizations or groups** such as schools, informal education settings, community organizations, businesses, regional partners, afterschool programs
- Draws on the **strengths of the different components** to support STEM learning
- Is based on **interactions and relationships** between these groups
- Has awareness that **STEM learning could occur at home or in different settings** outside of school
- Is situated within a **particular location and context**
- Supportive of **different engagement levels and knowledge of STEM**

STEM LEARNING ECOSYSTEMS

STEM ecosystems unite people, groups, and resources to create learning experiences for all people throughout their lifetimes.

This partnership model:

- Places learners at the center
- Recognizes that learning takes place across space and time
- Understands that context matters
- Creates pathways for learners
- Can be “nested,” with smaller local ecosystems forming larger regional ecosystems



STEM LEARNING ECOSYSTEMS

Advisor feedback

Defining and understanding STEM learning ecosystems

Important aspects for a successful STEM learning ecosystem

Understanding and leveraging relationships

STEM LEARNING ECOSYSTEMS

Advisor feedback

Defining and understanding STEM learning ecosystems

- Purely descriptive definitions are not as helpful as nuanced definitions that highlight what is actionable.
- Studying learning ecosystems can be done through an empirical or ecological approach.
- It is important to recognize the existing research / evaluation in order to identify areas to move this field forward.
- Understanding what makes a STEM learning ecosystem successful, in terms of its structures and functions, interactions, and intentionality is important (what makes it productive, durable, and resilient).

STEM LEARNING ECOSYSTEMS

Advisor feedback

Important aspects for a successful STEM learning ecosystem

- Diversity and redundancy in types of experiences, including the frequency of experiences types and content
- Connections to local policy and governance
- Initial and continued funding
- Collaborations and partnerships, reciprocity is important for resiliency
- Important to understand how to measure success within a learning ecosystem

STEM LEARNING ECOSYSTEMS

Advisor feedback

Understanding and leveraging relationships

- The role of STEM learning ecosystems (as active entities) is to build connections and create pathways.
- It is important to be culturally responsive, center communities and their needs, and involve people from those communities.
- Partnerships can be used to share ideas, strategies, and resources
  (increasing capacity and reinforcing opportunities for learners without increasing work)

STEM LEARNING ECOSYSTEMS

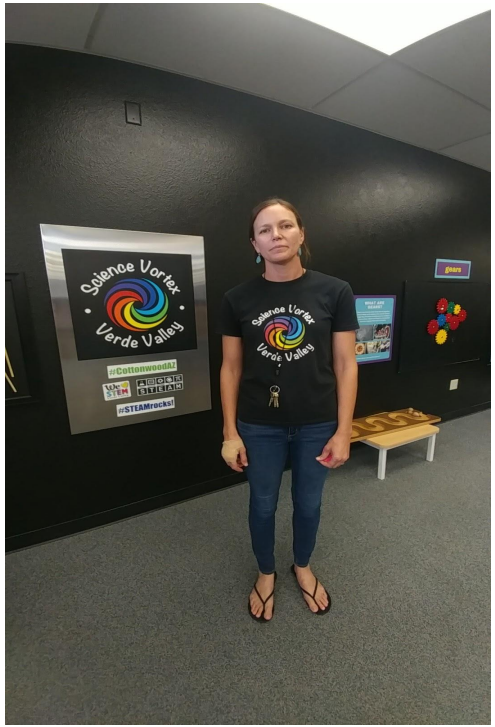
Understanding STEM learning ecosystems

All the exemplar projects recognized that they are a STEM learning ecosystem, at least to a degree. However there are different levels of intensity (or maturity) that may ebb and flow over time.

- Some also find the systems way of thinking valuable.
- They all noted that using a western derived framework may have limitations when applying to projects working with Indigenous communities (and other communities that interact holistically with STEM content)

STEM LEARNING ECOSYSTEMS

Understanding STEM learning ecosystems



Ecosystem sustainability relies on champions (and being able to successfully pass the torch), funding, and community buy-in (organizations, partners, etc.)

STEM LEARNING ECOSYSTEMS

Refining a definition for STEM learning ecosystems - SNOWBALLS!!!

One of the goals of this project is to refine and provide a clear pathway to explaining how a SLE works.

What do you notice that is missing from the initial definition?

STEM learning ecosystems unite people, groups, and resources to create STEM engagement and education experiences for all people throughout their lifetimes.

On one of the blank sheets of paper at your table

Write a concept or idea that you think needs to be included in the SLE definition.

When prompted *(WAIT…)* crumble the paper and throw it to someone in another part of the room.

Repeat

We will go three rounds then ask for folks to share an idea from the sheet in their hands.

STEM LEARNING ECOSYSTEMS

Refining a definition for SLE

Areas that the exemplars felt were missing from the shared definitions of STEM learning ecosystems include understanding or explaining

- why a particular ecosystem exists
- the connections within an ecosystem, the relationships, pathways, brokering etc.
- the organizational structure(s) that work in maintaining an ecosystem
- whether something is intentional or just happens to be an ecosystem
- incorporating different ways of knowing and perspectives in engaging with STEM learning
- the scale of an ecosystem

STEM LEARNING ECOSYSTEMS

Identifying characteristics of a strong STEM learning ecosystem

- Strong STEM learning ecosystems are **intentional** in what they are doing, why they are doing it, and how they are doing it.
- Strong STEM learning ecosystems are responsive to the **context** that they work in, incorporating the worldview of the communities that they work with.
- **Relationships** are important in creating or maintaining the work done by STEM learning ecosystems.

STEM LEARNING ECOSYSTEMS

Project activities

Ongoing / work to date

1. Complete three inquiry cycles that investigate learning ecosystems

   → Topics: definition/function, broadening participation, authentic STEM

   → Sources: lit review, interviews with experts and practitioners, team discussions

Future work

2. Study exemplary STEM learning ecosystems within SciAct
3. Develop a guiding framework of principles and practices
4. Provide professional development and resources for SciAct community
5. Share findings with the broader STEM engagement community

STEM LEARNING ECOSYSTEMS

NASA SciAct STEM Ecosystems Team

Connecting Subject Matter Experts, Communities, and Learners of All Ages

STEM LEARNING ECOSYSTEMS

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Thank you!

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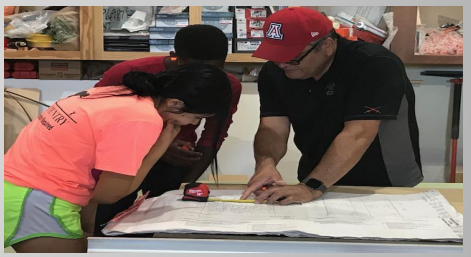
The following questions guided the research of the RAIN project:

- How do rural communities perceive, access, and engage in informal STEM learning?
- How, and to what extent, do community members identify themselves and their communities in relation to STEM?
- How do networks foster STEM related identity at personal & community levels?



CENTER FOR RESEARCH & EVALUATION

RAIN

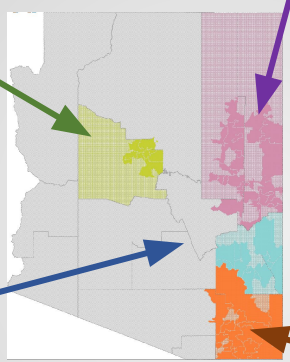
Cultivating Rural STEM Ecosystems

Verde Valley (VV)

Isolated river valley with four towns and one tribal nation.

Projects: 8
Reach: 2600+
Sq Mi: 748
Pop: 65,300

Audiences gathered at Yavapai College's Xplorology



Graham/Greenlee (GG)

Mining and agriculture community with 2 cities, 5 towns and 1 tribal nation.

Projects: 12
Reach: 3600+
Sq Mi: 6,489
Pop: 46,000

STEM Summer Camp - Eastern Arizona College

Navapache (NA)

Remote mountain community with 4 cities, 4 towns, numerous unincorporated villages, and 1 tribal nation. 80% of the land is federal or state controlled.

Projects: 22
Reach: 2000+
Sq Mi: 10,000
Pop: 100,000

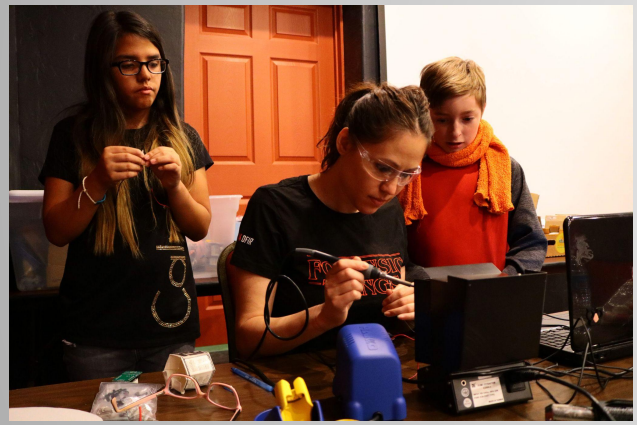
White Mountain Apache, Innovation Nation STEM Expo

Cochise County (CC)

Blends agriculture, military, and natural resources with 1 city, 5 small towns, and several unincorporated villages. Shares southern border with Mexico. 6220 sq miles with 127K population.

Projects: 12
Reach: 2005
Sq Mi: 6220
Pop: 127,000

Live Animal Exhibit at Bisbee Science Lab



RAIN

rural activation and innovation network

NSF DRL #1612555

Role of the Rural Innovation Council (RIC)

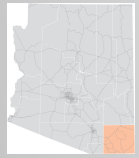
- Encourage a change in local identity in relation to the value of STEM learning
- Guide an understanding of the value of STEM learning on the local economy
- Create a scope of work that engages community resources and expertise

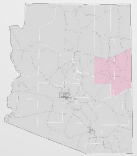
RIC Engagement

Each RIC developed a set of artifacts to help guide their efforts:

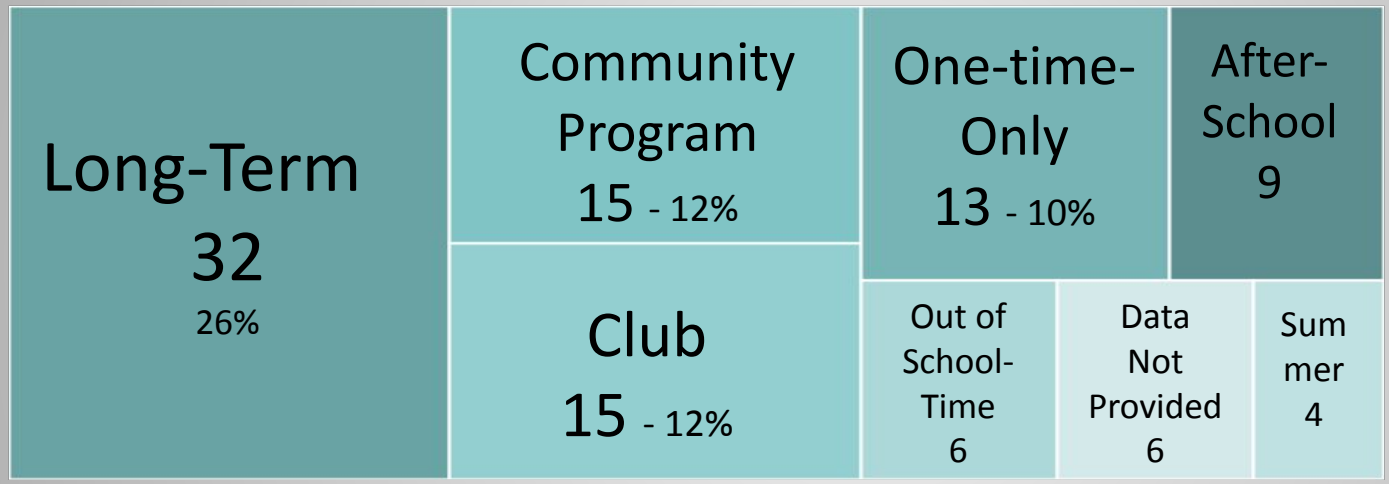
a. Asset Map
b. Needs Identification
c. Strategic Plan
d. Outreach Plan
e. Budget Plan
f. Media Plan

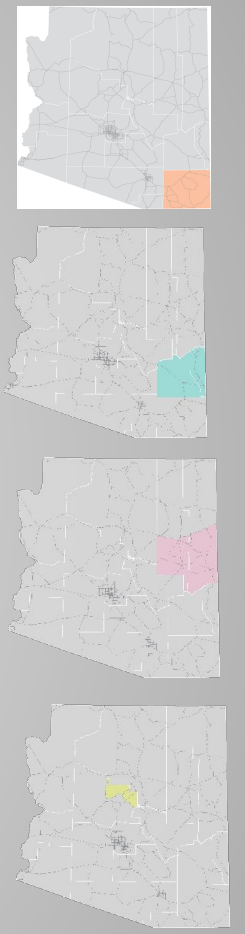
RAIN Research Findings






Outreach Program Type:
Across Regions

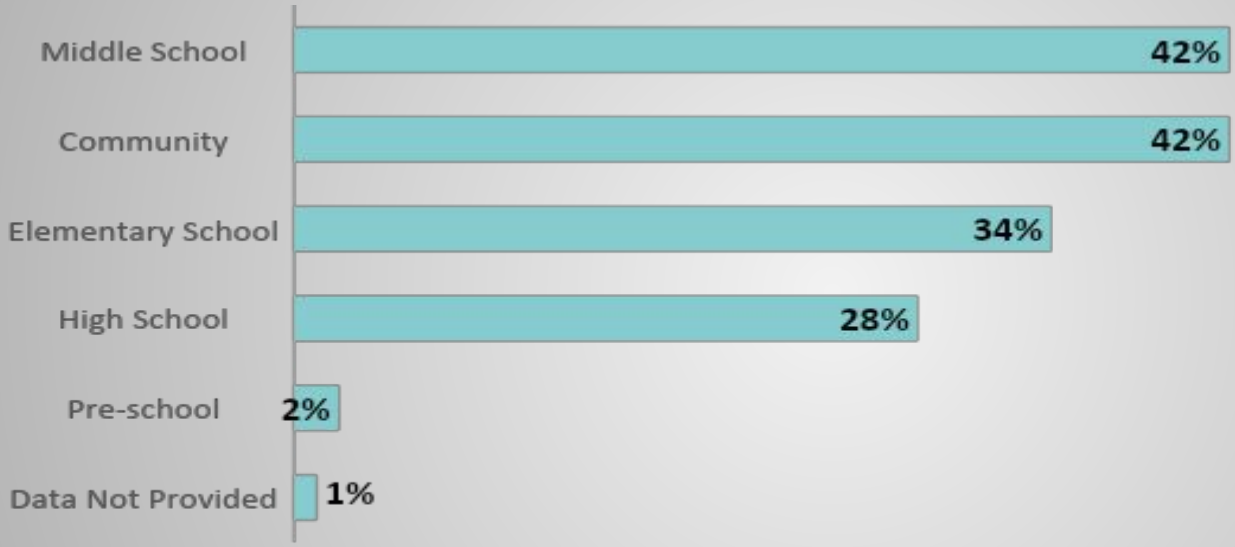


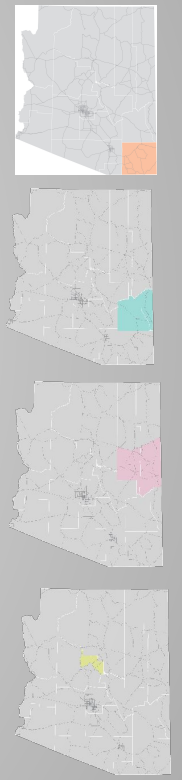


123

outreach projects funded

Outreach Audience: Across Regions

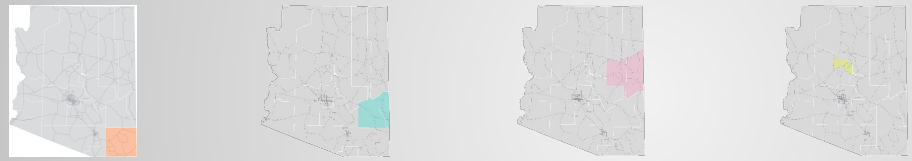




123

outreach projects followed

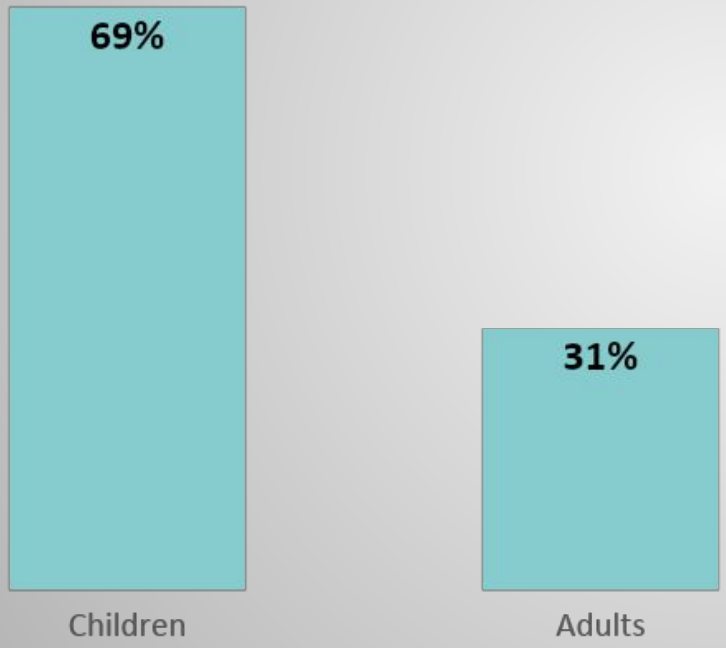
RIC Program Audiences



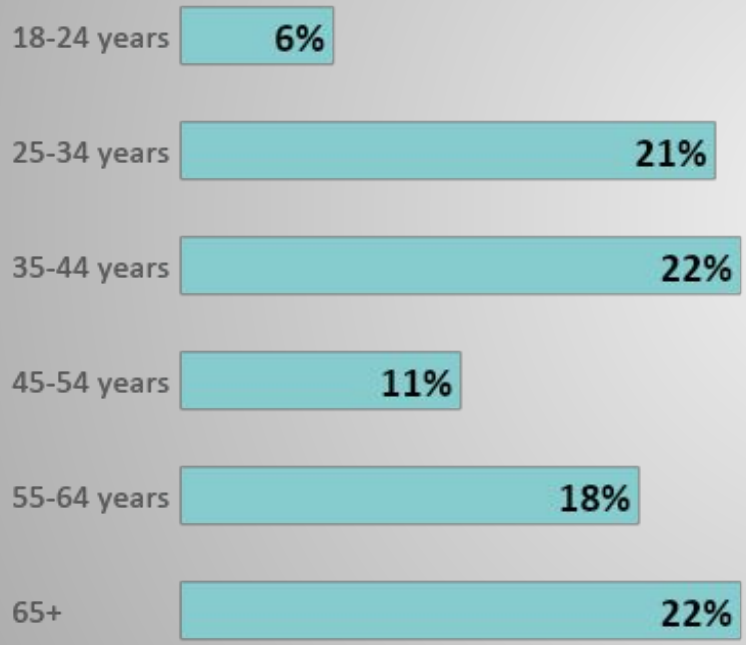
Children were twice as likely to attend outreach events

1104

individuals



The ages of adult attendees varied, with most being young adults



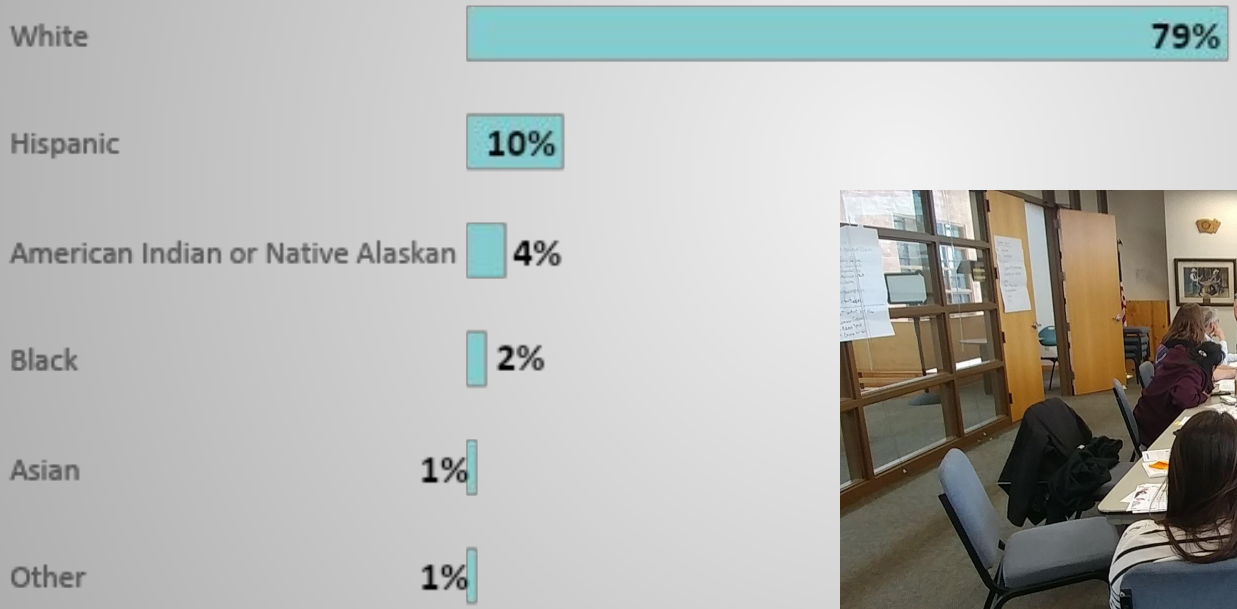
377

adults

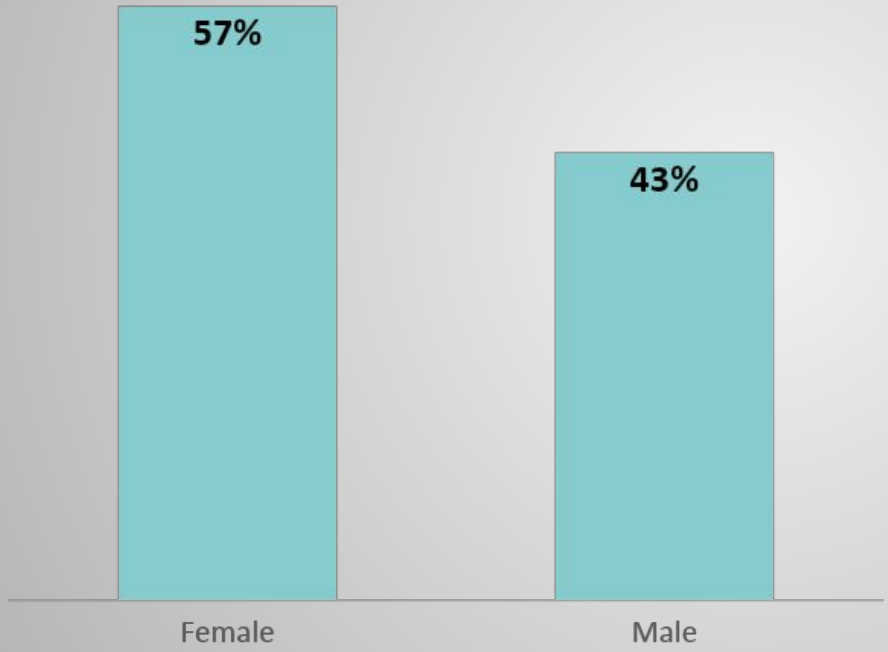
A majority of adult attendees identified as White

377

adults



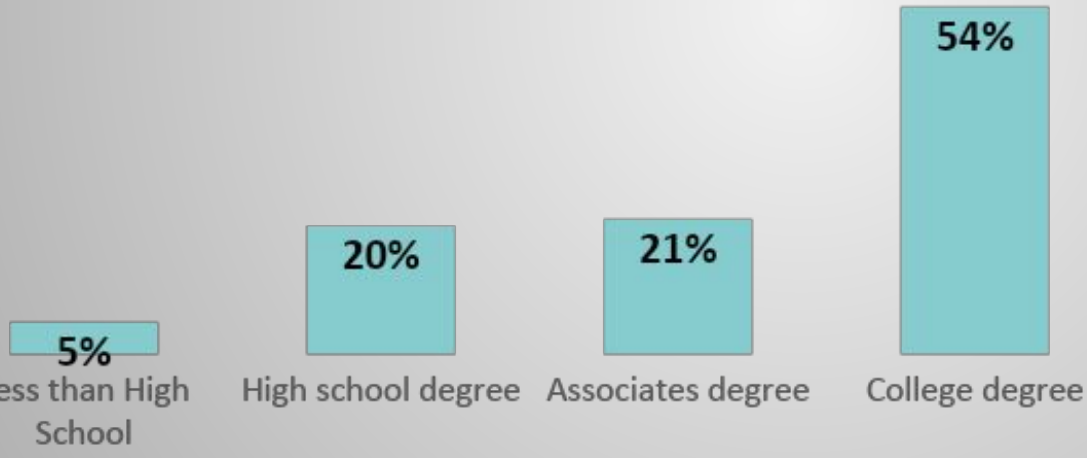
More women than men attended outreach events



377

adults

Approximately half of the adult attendees had a college degree



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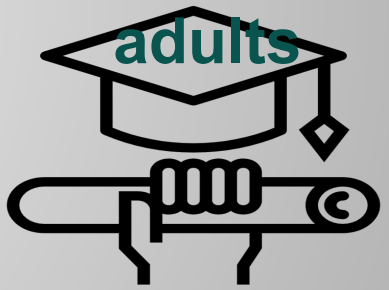
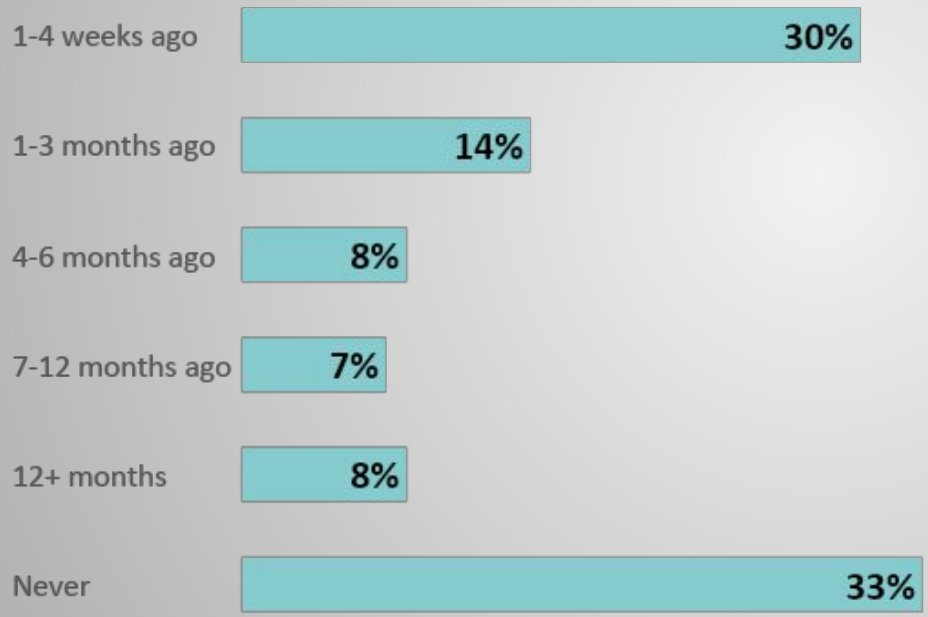


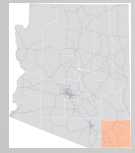
Attendees were split between those who had *never* attended a STEM event and those who had attended a STEM event recently

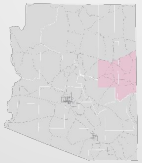


579

attendees

Practitioner Impact from Research






Research Implications

When entering communities or bridging between them:

It is important to **consider culturally-specific and locally-informed ways of thinking about PLACE**, including the recognition that definitions of **rurality** are contextual and widely varying.

Applications

How do you factor in
culturally-specific and locally-informed ways of thinking about PLACE?

Especially when hosting events or projects that rely on skill sets (coding, robotics, rocketry, etc.).

Or
Is this an issue for your team?

Program Considerations

Offer **practical applications** to everyday life within non-education contexts

Highlight **key** (non-education) **STEM industries** in the communities

Find ways to make STEM content **personally relevant and appealing** to people

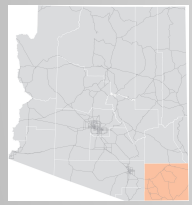
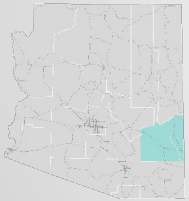
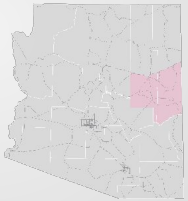
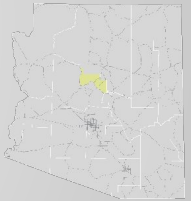
Research Implications

A focus on local content offers an opportunity for STEM learning practitioners to **leverage existing local industries**

mining, agriculture, breweries & vinyards, nurseries, water treatment, libraries

RAIN 2.0

Continuation as a Case Study with NASA SciAct Broadening Participation with STEM Ecosystems

About the Team

RAIN Leadership Partners

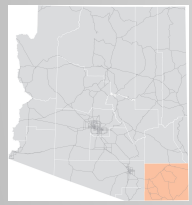
- Jeremy Babendure, Ph.D. – PI
  Arizona State University, Arizona Technology Council
- Kalman Mannis, Arizona Science Center
- Beth Nickel, M.Ed., Arizona Science Center
- Karen Peterman, Ph.D., Karen Peterman Consulting

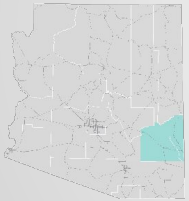
Project Research Team

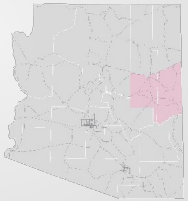
- COSI's Center for Research and Evaluation (CRE)
  - Gary Timko, Ph.D. – Co-PI
  - Dolly Hayde, M.A.
  - Justin Reeves Meyer, Ph.D.
  - Laura Weiss, M.A.
- Jill Stein, M.A. – Research Director (JKS Consulting)
- Eric C. Jones, Ph.D. – Affiliated Researcher, Network Analysis Lead (The University of

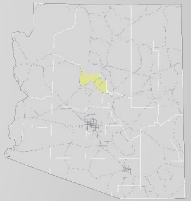
With additional contributions from Rebecca Nall, Martin Storksdieck, Ph.D. (Oregon State University), Andrew Vernon, Dania Wright, and the RAIN regional evaluation leads (Paulette LeBlanc, Dan Matchette, Lynn Winslow, and Tammy Gadeberg)

RAIN Research Methods









Research Methods

The research team used a **mixed methods approach** (qualitative and quantitative) to collect and analyze data during each of the three phases of this study, address the research questions, and to create an overall narrative for this study.

Qualitative approaches

- **RIC member and community partner interviews** (n=43) (Phase 1: See slide 8)
- **Community focus groups** (n=12) (Phase 1: See slide 8)
- **Literature review** (Phase 1: See slide 8)
- **RIC member interviews** (n=19) (Phase 2: See slide 9)
- **RIC member interviews** (n=21) (Phase 3: See slide 10)
- **RAIN governance COVID-19 response interviews** (n=3) (Phase 3: See slide 10)

Rationale: The research team used qualitative approaches to allow for in-depth exploration of more targeted issues, richer contextual understanding, and opportunities for RICs to describe their work in their own words.

Quantitative approaches

- **Community Member survey** (n=1,004) (Phase 1: See slide 8)
- **Community member survey** (n=572) (Phase 2: See slide 9)
- **RIC member COVID-19 response questionnaire** (n=15) (Phase 3: See slide 10)

Rationale: The research team used survey questionnaires to collect a volume of data that that could be analyzed using statistics, aggregated and/or compared across regions, and potentially generalized.

Research Methods

Links to coding rubrics (accessible by RAIN Leadership Team)

- Phase 1 and 2 RIC interviews and Phase 1 community focus groups:

2017-06-07_RIC Interviews Qualitative data coding rubric

- Open-ended question on Phase 1 community survey:

RAIN Phase 1 Community Survey_Q7 Coding Rubric_010418_clean copy

- New questions in Phase 2 RIC interviews:

RAIN_Phase 2 RIC Interviews_Q2&Q3_codebook

Phase 3 RIC interviews:

2020_05_01 Phase 3 RIC interviews Qualitative data coding rubric

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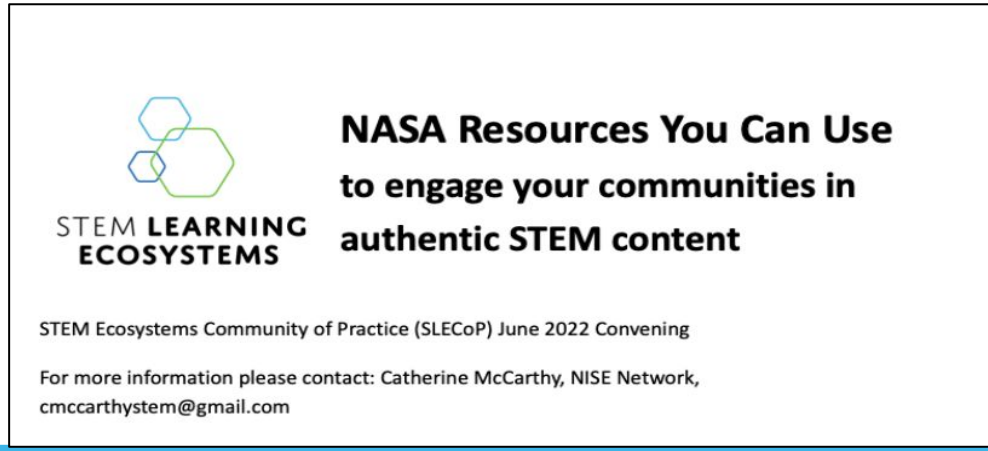
NASA Resources You Can Use

to engage your communities in authentic STEM content

- **Handout**
- **Video with 1 minute descriptions**
  https://www.nisenet.org/nasa-resources-showcase



NASA resources you can use

NASA Citizen Science

> https://science.nasa.gov/citizenscience
> https://science.nasa.gov/citizenscientists

NASA CitSci in practice
Let's go outside with GLOBE Observer and experiment with the Tree Protocol.
Please team up with 1 or 2 other people

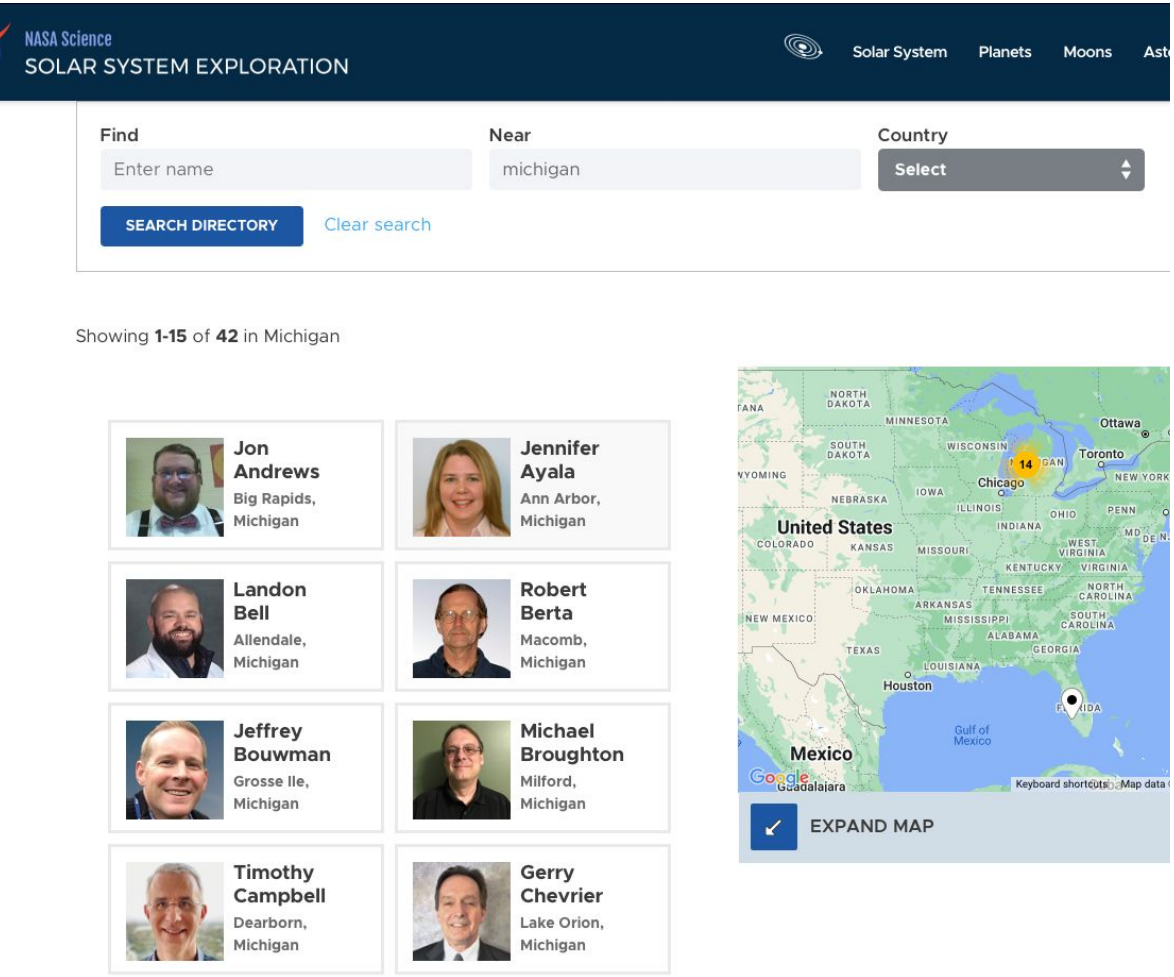
NASA resources you can use

NASA's Night Sky Network

Find local Astronomy Clubs

https://nightsky.jpl.nasa.gov

NASA resources you can use



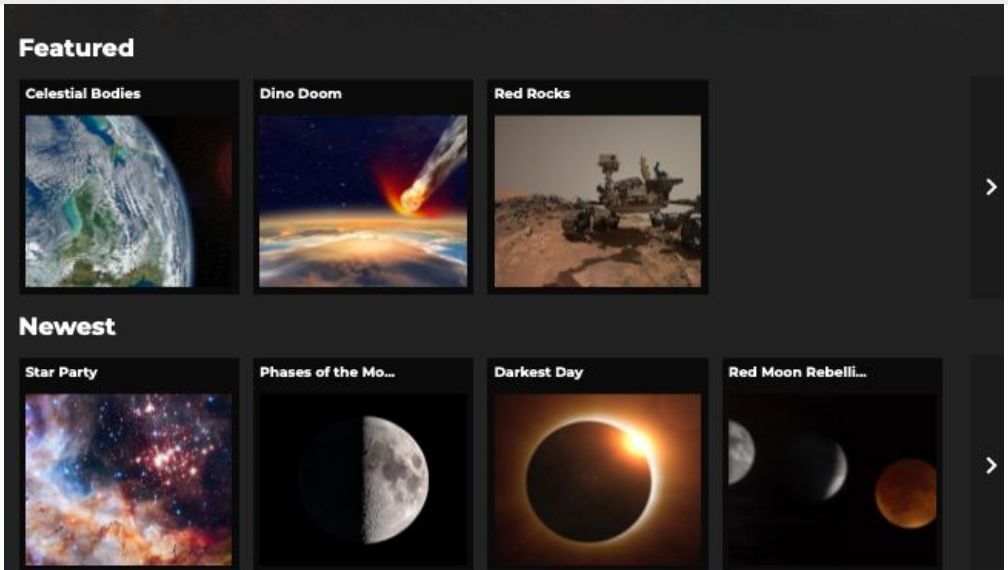
Solar System Ambassadors

Find local experts

https://solarsystem.nasa.gov/solar-system-ambassadors/directory/

NASA resources you can use

Take Your Learners Anywhere

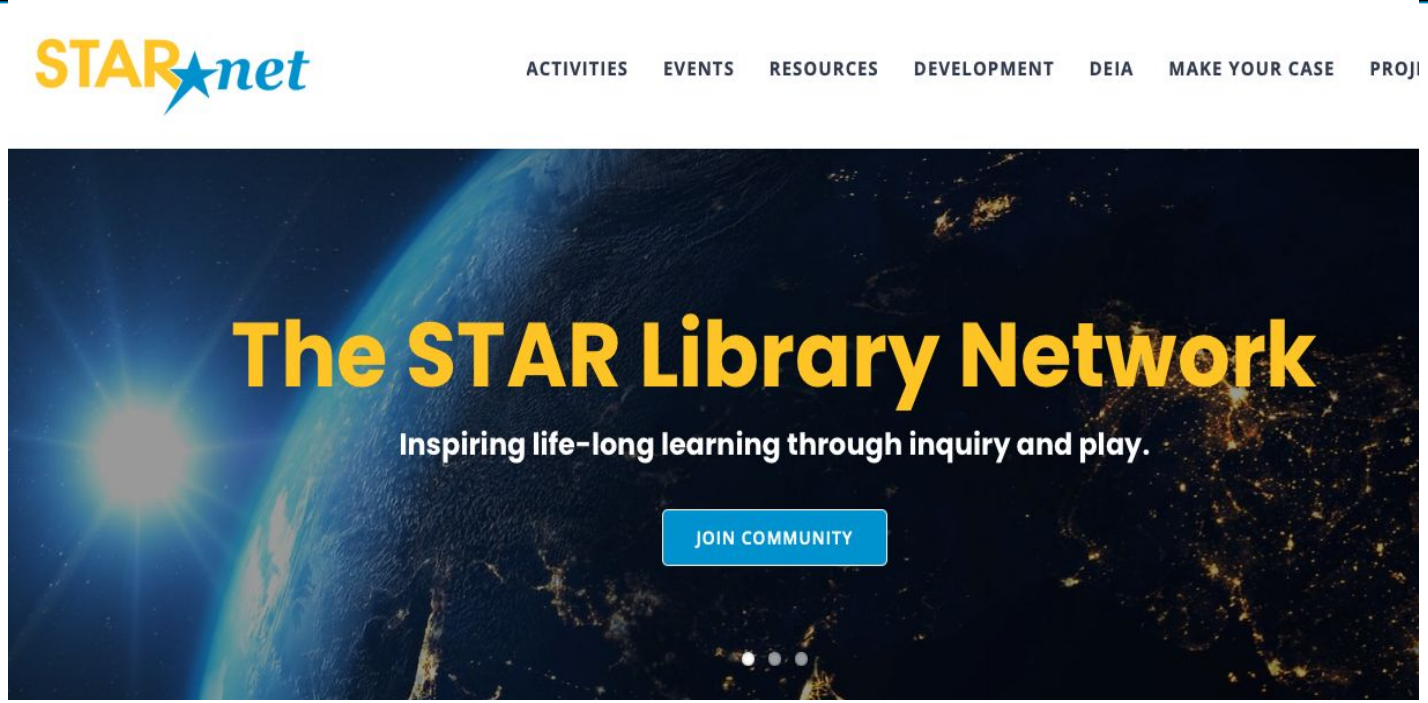


Infiniscope

Interactive Virtual Field Trips & Educator Development platform

https://infiniscope.org

NASA resources you can use



STARnet Library Network

https://www.starnetlibraries.org

NASA resources you can use

2022 NASA ASTRO CAMP® Collaborative Partner Program Website Update

Join NASA's ASTRO CAMP® Collaborative Partners Program (ACCP)

Each year, NASA's ASTRO CAMP Collaborative Partners Program provides collaboration opportunities for ***youth service organizations, museums, libraries, schools, and universities*** interested in presenting the NASA's ASTRO CAMP activities in their community with training and resources provided by NASA ACCP specialists. The NASA ACCP programs listing below are the official 2022 ACCP programs featuring the unique 2022 ***We Go! Bringing NASA Science Home Together!*** STEM activities for students. The program contacts, dates, and locations are identified for you to locate and contact an official NASA ACCP program in your area. Each program listed has a trained 2022 ACCP facilitator/ educator using the most current NASA resources providing a connection for all youth to NASA Science Missions, Challenges, and resources in Astrophysics, Heliophysics, Earth Science, and Planetary Science. The website and lists are updated weekly so be sure to check back for additional programs, dates, and contacts to be added.

NASA's ASTRO CAMP® Collaborative Partners Program

https://www.nasa.gov/centers/stennis/education/students/astrocamp.html

NASA resources you can use

Moon

A compilation of resources for engaging the public in the Moon, the Moon Landing 50th Anniversary, the Apollo missions, and the Artemis missions.

Mars

A compilation of resources for engaging the public in the Mars, Mars rovers, and the Mars Perseverance landing.

Solar Eclipses

A compilation of solar eclipse resources including resources for the October 14, 2023 annular solar eclipse and the total solar on April 8, 2024.

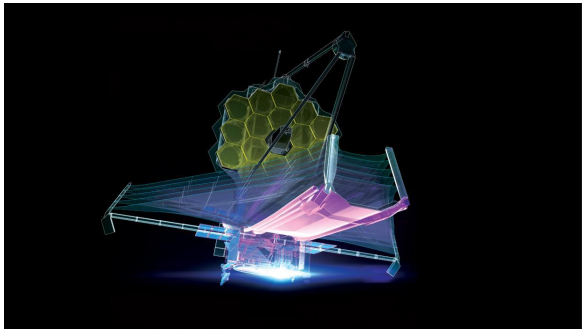
Lunar Eclipses

Check out the upcoming total and partial lunar eclipse events in the United States. During a lunar eclipse, Earth comes between

NISE
NATIONAL INFORMAL
STEM EDUCATION
NETWORK

www.nisenet.org/browse-topic

NASA resources you can use



James Webb Space Telescope

https://www.nisenet.org/webb

Artemis Moon Missions

https://www.nisenet.org/moon

2023 & 2024 Solar Eclipses

https://www.nisenet.org/solareclipse

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