NATIONAL ACADEMIES *Sciences Engineering Medicine*

Convocation on the Status of Informal Science and Engineering Education

Welcome to our Virtual Poster Gallery! As part of this event, we requested posters from meeting attendees to capture insights from the field in response to one or more of the following questions:

- What are some examples of research or practice that have changed the way we approach informal science and engineering education since the publication of Learning Science in Informal Environments in 2009?
- Over these last 15 years, what has helped to move the field forward? For example, what resources, toolkits, theories, concepts, evaluation approaches, communities, or funders have advanced the field?
- Who are some of the “unsung heroes” who have driven innovation in informal science and engineering education at local and hyperlocal scale?
- How has informal science and engineering education influenced other fields of learning and engagement outside of STEM?
- What skills and assets have the field of informal science and engineering education developed that are particularly relevant in today’s STEM learning landscape?

Advancing Family Learning in Informal Science and Engineering Education

CENTER FOR
EQUITABLE FAMILY STEM LEARNING
at TERC

Center for Equitable Family STEM Learning

We are a group of researchers, educators, and community advocates dedicated to collaborating with families to elevate their voices and perspectives, understand the unique ways they engage with STEM outside of school, and develop new approaches to addressing systemic inequities in STEM education.

Building on a Rich History

The *Learning Science in Informal Environments* report showcased research describing family-based learning in different contexts and exploring promising approaches to supporting these interactions. Advances in theory, research, and practice since 2009 have both extended this work and emphasized the need to rethink how we understand and support families. Moving forward, we advocate for applying critical and equity-centered lenses to our understanding of families, bringing renewed attention to the diversity of family structures and cultures, and developing collaboration models for partnering with families towards more equitable and just education systems.

What happens when we abandon the idea that there is one right way to parent or one model of what a family should look like?

Research across the world has long demonstrated there are many ways to raise children and that our ideas about parenting and families are situated within our own cultural experiences, backgrounds, and values.

What does it look like when families co-lead and not just participate in STEM education initiatives?

The field has experienced a shift towards participatory designs and co-constructed learning models that create opportunities to collaborate with families in new ways across learning contexts.

What is possible when we center family knowledge, goals, and values and not institutional agendas as the foundation for STEM learning?

Equity scholars have laid the groundwork for expanding what counts as science and engineering learning, including recognizing family cultural knowledge and rethinking how we assess learning in diverse and dynamic environments.

How can we leverage our work with families outside of school to transform formal education systems?

Research on informal family STEM learning is poised to help transform education systems more broadly, including teaching in schools and the relationships between schools and communities.

This material is based upon work supported by the National Science Foundation under Grant Numbers 2224247, 2115463, 1930848, 1906409, and 1515628. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

AI Literacy in Informal STEM Learning Environments: Encouraging Responsible Use of AI Systems and Tools

Pati Ruiz, Ed.D., Sana Karim, Kelly Mills, Ph.D., and Keun-woo Lee

AI Literacy Definition

AI literacy includes the knowledge and skills that enable humans to critically understand, use, and evaluate AI systems and tools to safely and ethically participate in an increasingly digital world.

Source: Digital Promise, June, 2024

AI Literacy: A Framework to Understand, Evaluate, and Use Emerging Technology

The rapid rise of AI demands that users understand how to critically engage with these tools, from data privacy concerns to recognizing AI-generated content. Our discussions with informal STEM educators throughout 2024 revealed a critical gap: informal STEM educators need specific guidance for teaching AI literacy in out-of-school settings. We have worked to co-designed guidance for informal STEM educators, centering the needs of science centers, museums, and informal STEM education programs can safely, effectively, and responsibly use AI systems and tools with their communities.

Understanding AI

Understanding AI is a **technical knowledge set**. It applies and extends computer science and computational thinking practices of **using data and creating automations** and underlying skills such as **algorithmic thinking, pattern recognition, abstraction, and decomposition.**

Using AI

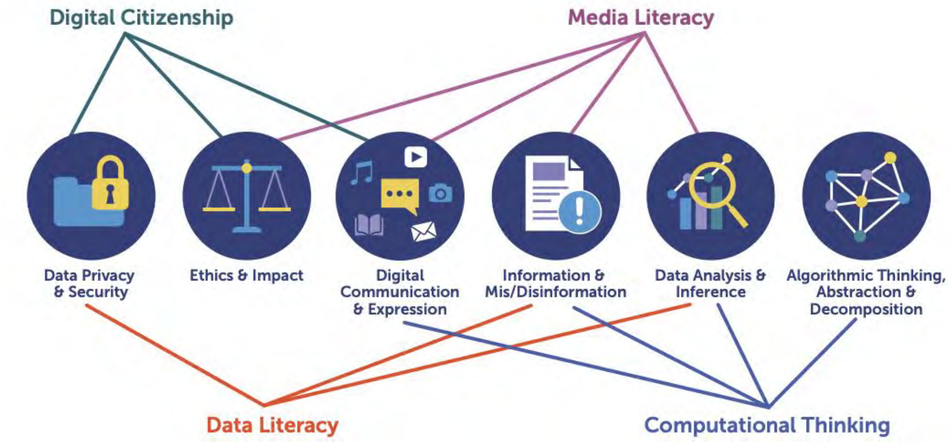
Building on the research-based frameworks, we distinguish between three ways to engage with AI in educational contexts: **Interact, Create and Apply.**

Evaluating AI

Evaluating AI is the most critical element of AI literacy. All too often, people use AI passively without considering the privacy, safety, or societal implications of doing so.

Connecting AI Literacy to Existing initiatives

AI literacy skills connect to initiatives that educators have been discussing and implementing in response to emerging technologies for decades. These include, but aren't limited to, computational thinking, data literacy, digital citizenship, and media literacy. These deep connections can allow school leaders to expand on existing initiatives and learning pathways to include AI literacy, or to introduce additional related learning objectives alongside AI literacy initiatives. Below, we explain how AI literacy practices are connected to existing initiatives.



Strategies to Promote AI Literacy

Provide Guidance for Adoption and Evaluation

There is a need for policymakers and school leaders, in partnership with educators, students, and families, to develop guidance for the adoption and evaluation of AI tools in K-12 education. There are several factors to consider when choosing to adopt or use an AI system or tool, including accessibility and equity, data ownership and privacy, transparency, and impact.

Facilitate Ongoing, Just-In-Time Professional Learning

Safe and effective integration of AI tools in education depends on AI literate teachers. However, it is not reasonable to assume that teachers will learn how to understand, evaluate, and use AI tools on their own. Professional learning aimed at enhancing AI literacy can support teachers to understand how to promote AI literacy skill development.

Promote Awareness and Agency

Because AI literacy is a valuable skill for everyone, schools and districts can support not only their students, but also families, caregivers, and their broader community to be aware of how AI tools are being used. Developing this understanding—including increasing critical consciousness of how AI tools can perpetuate and exacerbate existing inequities in our society and raising awareness about algorithmic bias and advocating for changes in policies around algorithms and automation in our society—can enable community members to to decide if and how they will use these tools to impact their lives and society.

Digital Promise
Accelerating Innovation in Education

Learning Sciences Research
Presented by Digital Promise

Mills, K., Ruiz, P., Lee, K., Coenraad, M., Fusco, J., Roschelle, J. & Weisgrau, J. (2024, May). AI Literacy: A Framework to Understand, Evaluate, and Use Emerging Technology. https://doi.org/10.51388/20.500.12265/218

digitalpromise.org/AIliteracy

Building Capacity Amid Turnover, Shifting Priorities, and Growing Needs

Reflecting on 15 Years of Progress and Persistent Gaps in OST Educator Support

2009 Report Findings & Recommendations

"Ensuring that the principles of informal science learning (e.g., learner choice, low-stakes assessments for learners) are sustained as out-of-school- time programs grow will require careful attention to professional development, curricula, and best practices."

"Even facilitators who are not experts in science (e.g., in after-school and community-based programs) can serve as intermediaries to informal science learning experiences. "

Recommendation

"**Recommendation 4:** Front-line staff should actively integrate questions, everyday language, ideas, concerns, worldviews, and histories, both their own and those of diverse learners. To do so they will need support opportunities to develop cultural competence, and to learn with and about the groups they want to serve."

Lingering Questions/Concerns

- How can OST educators access professional learning (PL) that responds to their unique contexts?
- How can PL accommodate the diversity of the OST field and the youth and families it serves?
- What are fundamental skills that can remain relevant in the face of changing priorities, such as for AI integration and career connections?
- How can programs be supported to offer PL given high turnover and the investment risk?

Findings from ACRES

1. Virtual training makes PL accessible. Extended PL over a series of sessions allows reflection on real practice and visible skill improvement.
2. Training regional leaders in PL models and providing clear training modules allows them to adapt PL for their programs and community. Scaffolds are needed to point out opportunities for adaptation.
3. Focusing PL on fundamental skills that emphasize staff-youth relationships leads educators from a variety of backgrounds to see their value as STEM facilitators.
4. Credentialing can recognize and reward skill development. Educators and site directors need financial support reflect skill aquisition in salaries and bonuses.

To learn more about ACRES (Afterschool Coaching for Reflective Educators in STEM) visit our website to browse PL modules, explore our resources for training coaches, and review research that supports our work.

Building Capacity for Teaching & Learning

Jedda Foreman
Lawrence Hall of Science, University of California, Berkeley

The Lawrence Hall of Science

*How can **professional learning** lead to **organizational transformation**?*

Attending to organizational practices, policies, mental models, and interpersonal relationships as well as instructional practices lends a clue...

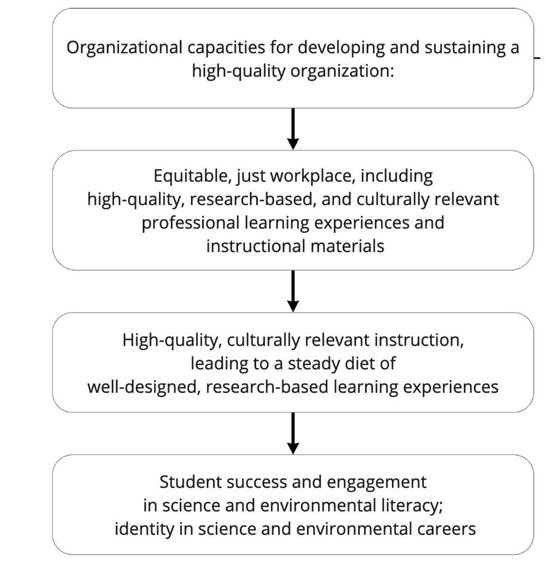
- **Example Research Insight 1:** Organizations using materials designed for capacity building developed a more reflective practice & culture of ongoing professional learning. This contributed to redesign of instructional materials & empowered educators to implement changes, leading to richer outdoor science learning experiences.

- **Example Research Insight 2:** Participants in a racial equity focused capacity building workshop series were able to deepen their engagement in critical reflexivity—reflecting on & interrogating how internalized beliefs, values, & ideologies can further reinforce the status quo within their workplaces. This reflection led to (1) significant shifts in the operations of organizations & (2) acknowledgement & discussion of equity within more aspects of the organization's work.

Participants in the Working Towards Racial Equity workshop series discussing organizational change

Learn more and connect with us!

https://lawrencehallofscience.org/



Example Theory of Change based on capacity building approach, representing the "upstream investments" required for student success and engagement.

"This is the first time I've been in an organization and part of an initiative where I've seen ***people actually wanting to learn and wanting to change***."

- participant in the Lawrence Hall of Science's Working Toward Racial Equity workshop series

Collaboration + Good Coffee = Fostering Formal & Informal Connections

Changing Practice

In 2011, the North Carolina Department of Public Instruction (NCDPI) K-12 Science section and the NC Office of Environmental Education and Public Affairs embarked on a simple, yet effective, model to build integral connections between formal and informal educators to support student learning. Each December the two agencies host a daylong meeting that allows informal educators to meet with NCDPI science consultants. The annual meeting provides opportunities to discuss problems of practice, receive updates on state standards, and engage in current teaching and learning practices, while enjoying good coffee. The meeting emphasizes the importance of establishing local partnerships with formal educators and the need to align programming with the state's K-12 Science Standards.

Highlighted Partnerships

- The Soil and Water Conservation District in Gaston County partnered with the local K-12 school district to develop engaging lessons and help 5th graders to better understand weather and climate.
- The Hub Farm (a 30-acre farm, forest and aquatic educational center) in Durham, partnered with the local K-12 school district to provide content specific field trips, student internships, service learning, and professional development for teachers.
- UNC's Institute for the Environment collaborated with The Academy of Green Technology (a CTE program) in Fayetteville, to prepare high school students to have the skills necessary to lead the emerging green and global economy through interdisciplinary learning experiences.

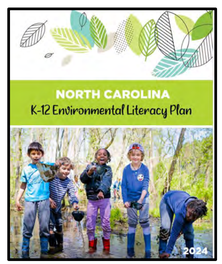
North Carolina Environmental Literacy Plan

The fertile soil, clean water, clear air, and rich biodiversity in NC are the cornerstones of its vibrant economy, the health of its residents, the safety of its communities, and the development of its most precious resource: our students. To thrive and prosper, NC's students must gain the skills and knowledge to make informed decisions about environmental issues. With this critical need in mind, the NCDEQ and the NCDPI partnered with Environmental Educators of NC to develop an Environmental Literacy Plan. Although this plan's focus is K-12 students, it is important to note that environmental education can start in preschool and last a lifetime – a journey often full of profound joy, wonder, and insight.

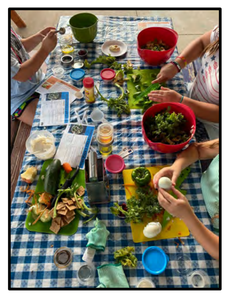
Rethinking Roles in STEM Education

- Fostering intentional relationships at the local level–uniting formal and informal partners
- Purposeful in implementing the NC K-12 Science Standards–establishing common language inside and outside the classroom
- Participatory science opportunities–community science–shared projects
- Environmental Educators Certification–nationally recognized PD program–700^{+} certified educators working in NC

The garden at the Hub Farm in Durham, NC



North Carolina Environmental Literacy Plan (cover image)



Students visit the Hub Farm and prepare vegetables harvested from the garden.

Future Endeavors

- Annual Informal/Formal Educator Meetings
- Collaborative Outdoor Classroom Symposium
- Members of State-level Science Leadership Teams
- NC Atlas of Phenomena

Resources

- Collaboration and Good Coffee= Connected Science Learning Success
- NC Environmental Literacy Plan
- NC Science Hub- Nonformal Education

North Carolina Department of PUBLIC INSTRUCTION

N.C. ENVIRONMENTAL EDUCATION

NORTH CAROLINA Department of Environmental Quality DEQ

Dr. Debra Hall, Benita Tipton, Lisa Tolley & Marty Wiggins

DEVELOPMENTS IN INFORMAL STEM EDUCATION, 2009–2025

Convocation on the Status of Informal Science and Engineering Education

National Academies of Sciences, Engineering, and Medicine | June 16–17, 2025

ASU
Center for Innovation in Informal STEM Learning
Arizona State University

What are some examples of research or practice that have changed the way we approach informal science and engineering education since 2009?

Arizona State University

Participatory approaches

- Co-creation and shared authority
- Community science and citizen science
- Mutual learning among scientists, publics and municipal leaders

NISE Network

Attention to context and relevance

- Connections to people and place
- Society, culture, and human values
- Stories about past, present, and futures

NISE Network

Inclusion of people and perspectives

- Pathways to participation
- Balance in resource distribution
- Productive reflection and dialogue

Over the last 15 years, what has helped to move the field forward?

NISE Network

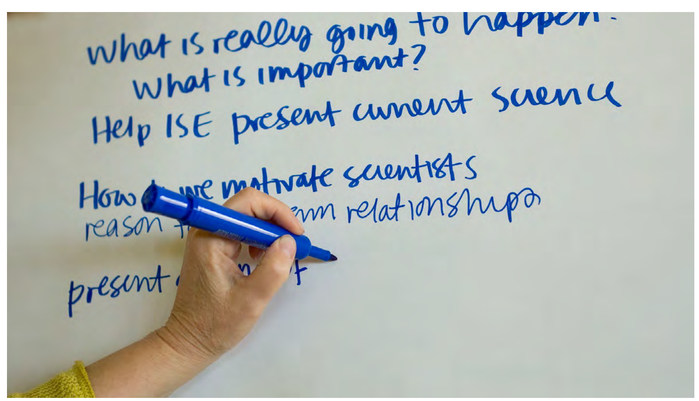
Collaborations

- Networks
- Communities of practice
- STEM learning ecosystems

NOAA/Smithsonian

Culture of sharing

- Models and frameworks
- Professional resources and engagement materials



NISE Network

Evidence-informed approaches

- Integrating research, evaluation, and practice
- Gathering and using data as a fieldwide norm
- Learning from personal and lived experience

IOWA Science PHENOMENA

Iowa Science Phenomena is a website and service dedicated to the creation, curatation, collection and sharing of the growing collection of Iowa focused user-generated, media-based, standards-aligned, science phenomena resources.

Morgan[1], T.L., Hyde[2], C.J., Castillo[2], V.A., Smith[1], C.J. || [1]Iowa PBS || [2]Research Institute for Studies in Education (RISE), Iowa State University

Digital Place-Based Phenomena: Program Research and Evaluation Results

PURPOSE

The Research Institute for Studies in Education (RISE) partnered with Iowa PBS to pilot test and evaluate the use of Iowa Science Phenomena web-based science content (iowaphenomena.org) in science classrooms within two Iowa school districts. The purpose of the pilot test was to measure the accessibility and reception of the Iowa Science Phenomena content by teachers and students. This poster demonstrates the results from teachers' interests in Iowa-based science content and their expressed desire for more training and access to content.

METHODS

Surveys were conducted to gain feedback using Likert-scale and open-ended questions. Classroom observation data were collected using field notes during lessons. The analysis consisted of summarizing survey responses regarding teacher's experience using the Iowa Science Phenomena website and key areas of feedback about the website content.

RESULTS

Teachers were asked to respond with their level of experience using the Iowa Science Phenomena website and placed-based phenomena teaching practices. Twenty-eight teachers from two Iowa districts participated in the survey. The majority responded they had little experience with the website or place-based phenomena. Further questioning showed teachers were interested in learning more about the website content. The majority of teachers responded they would like to or plan to use Iowa Science Phenomena. Few said they currently use the website sometimes, and none responded they use it frequently.

Table 1. Please rate your current experience with each of the following items.

	n	No Experience	Little Experience	Moderate Experience	Extensive Experience
The Iowa Science Phenomena website	28	20 71.4%	6 21.4%	1 3.6%	1 3.6%
Content available on the Iowa Science Phenomena website	28	20 71.4%	5 17.9%	2 7.1%	1 3.6%
Classroom teachers' contribution to Iowa Science Phenomena	28	22 78.6%	4 14.3%	2 7.1%	0 0%
Overall knowledge of using Iowa as background for science lesson	28	18 64.3%	7 25.0%	2 7.1%	1 3.6%
Phenomena-based teaching practices	28	17 60.7%	5 17.9%	5 17.9%	1 3.6%
Phenomena-based learning practices	28	17 60.7%	7 25.0%	3 10.7%	1 3.6%

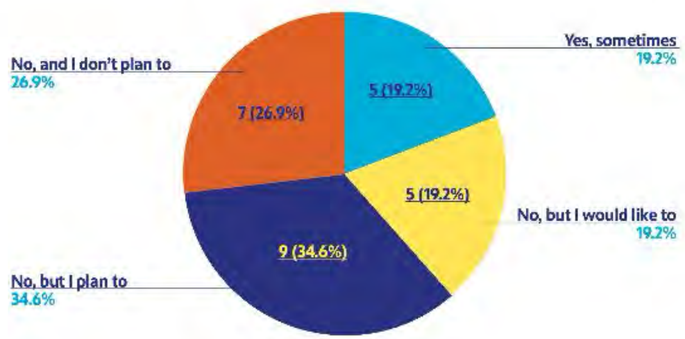


Figure 1. Have you used the Iowa Science Phenomena website content before?

Classroom observations consisted of time spent in lecture, student engagement, activity and teacher feedback. Feedback from teachers included their excitement to share content related to Iowa with their students. One teacher expressed her appreciation of the accessibility of the videos since taking students on field trips has been difficult due to both budgets and COVID-19.

DISCUSSION

This research shows while teachers have limited experience using the website, they find place-based science content important and relevant. Teachers expressed excitement to learn about the content, and eagerness to use and implement the content into their lessons. Some feedback included the need for more content that matched state science standards and more training on how to use the website. Additionally, teachers would like to have opportunities to contribute to the website. Overall, the program evaluation and research results showed a positive impact on teacher engagement with place-based phenomena science content.

Based on these results, Iowa PBS reviewed and refined the Iowa Science Phenomena outreach and engagement strategies to more effectively reach Iowa teachers in targeted grade levels and communities. Through these targeted engagement strategies:

- Iowa Science Phenomena website analytics showed significant growth in usage, with a 51 percent increase in Pageviews and a 54 percent increase in Unique Pageviews, year over year (Google.com, 2022).
- Iowa PBS has sought out new partnerships including a unique partnership with pre-service elementary teachers in Iowa colleges and universities.
- Iowa PBS has strengthened relationships with existing partners including Iowa Conservation Education Coalition (ICEC), Iowa Association of Naturalists and Iowa Governor's STEM Council.

Funding provided by the Resource Enhancement and Protection Conservation Education Program (REAP CEP), the Corporation for Public Broadcasting, Musco Lighting, Pella Windows & Doors and Alliant Energy.

Empowering STEM Confidence and Career Aspirations through NASA–21st CCLC Partnership

Key Takeaways

1. **Increased Educator Confidence & Quality of Instruction >** 681 facilitators reported increased confidence and capacity in implementing engaging STEM activities, based on post-program feedback (Phase 4). [*Strands: 2, 4, 5*]

2. **Elevated Student Interest in STEM Careers >** 96.2% of facilitators (educators) perceived higher student interest in STEM was due to program participation (Phase 4). *[Strands: 1, 6*]

3. **Authentic, Scalable NASA Engagement >** 695 virtual NASA scientist/engineer connections across 6 years (Phases 1-5). [*Strands: 1, 3, 5*]

By The Numbers

(As of May 30, 2025)

Total Students Reached	Total Facilitators (Educators)	Sites Across 6 Years	Virtual NASA Connections
7,175	**1165**	**645**	**695**

Sustained Partnership

The NASA and U.S. Department of Education 21st Century Community Learning Centers (CCLC) Engineering Design Challenge Partnership was piloted in 2013-2014 (Phase 1) with 3 states and expanded to as many as 25 states with operations in 2015-2016 (Phase 2), 2016-2017 (Phase 3), 2019-2021 (Phase 4), and 2025 (Phase 5 - ongoing).

Impact Quotes

> I really enjoyed the design process that we took.
>
> -- Student

> They now want to become engineers. They want to become scientists. They see themselves now as scientists. They call themselves scientists and engineers now and that's what's so exciting about this program, is that it really makes them think of themselves as somebody who would do this as a career.
>
> -- Administrator

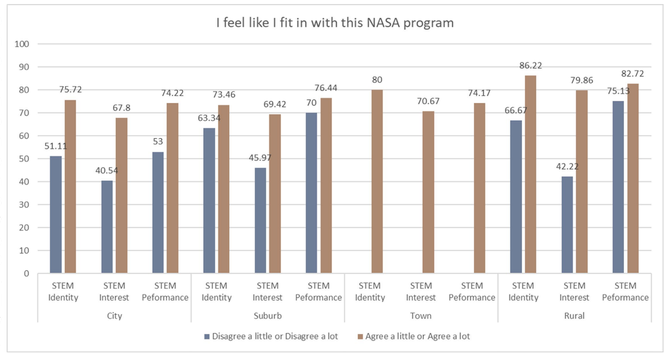
Alignment to The Literature

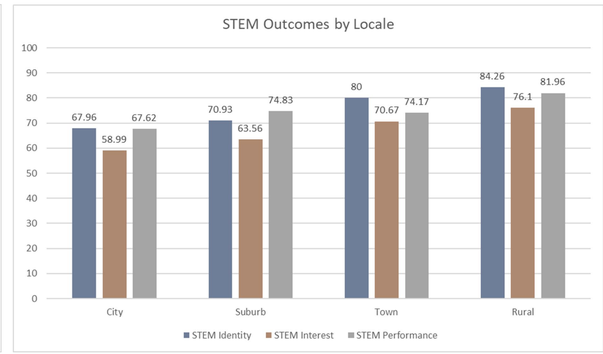
National Academies Report Learning Science in Informal Environments (2009)

- Design for interactivity and learner-driven inquiry (*Strands 3, 4*)
- Promote excitement and long-term engagement with STEM (*Strand 1*)
- Foster science identity development, especially in underrepresented groups (*Strand 6*)
- Build educator capacity and equitable STEM access (*Strands 1, 2, 6*)
- Sustain local-national partnerships rooted in community needs (*Strands 5, 6*)

Key Findings Alignment to Existing Research

Positive Association with Student Sense of Belonging > Preliminary data from the 2025 study show a positive association between students feeling that they "fit in" with the 21st CCLC program and K-12 STEM Inventory outcomes.

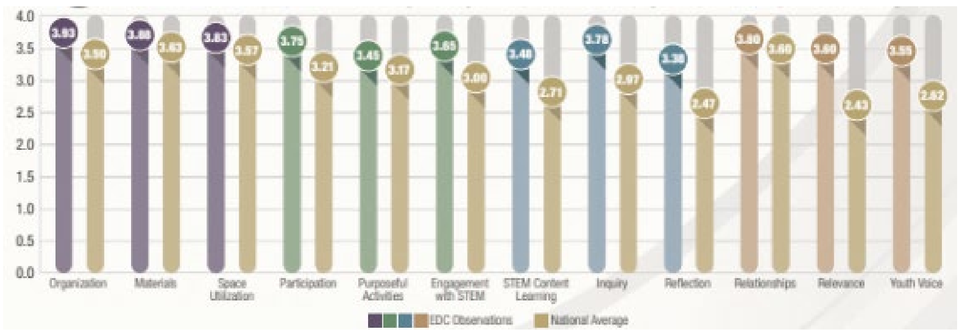




Place-Based Program Design > Preliminary data from the 2025 study show positive student results across all constructs of interest. Rural youth outscore city peers by 15-17 points on STEM identity (84 v 68), performance (82 v 68), and interest (76 v 59).

Dimensions of Success (DoS) Observations Findings

(Phase 4 Implementation DoS Observation data comparison to national averages)



Independent DoS observations> scored higher than DoS National Averages on 12 dimensions. Overall DoS Mean Combined Score (3.65). DoS scores of 3 or higher represent a high-quality STEM program being observed (The Pear Institute, 2019).

Poster Submission Collaborators

- Rick Gilmore, NASA OSTEM Program Manager
- Aime Black, NSTEM Contract Program Manager
- Spencer Scanlan, NSTEM Contract Evaluation Specialist
- Andrea Muse, NSTEM Contract Evaluation Specialist

Everyday Science Talk at Home: A Powerful Driver of Youth STEM Identity & Lifelong Learning Pursuits

- Identify salient characteristics *of* ***everyday science talk*** with ***family & friends***
- ***Science talk*** & youth's ***STEM identity*** development & ***career choice***

Science Talk Powerfully Shapes STEM Identity, Regardless of Parents' Academic Background or Access to Costly Resources

- ***Low-cost*** and widely accessible
- ***Don't need*** *special resources*
- ***Doesn't require*** *financial investment*

Parents and family ***engaging*** in ***science-related conversations***

Frequent family conversations about STEM

Increases ***STEM identity*** regardless *of* ***parents' academic background***

(Dou et al. 2019)

(Dou et al. 2022)

Our Research Approaches

Multi-Temporal

- Cross-sectional
- Longitudinal
- Recursive

Multi-Methods

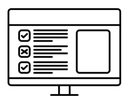
- Phenomenology
- Case Studies
- Multivariate
- Mixed

- Youth
- Siblings

Interviews

- Semi-structured
- Informal
- Group

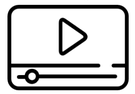
- Young Adults
- Peers



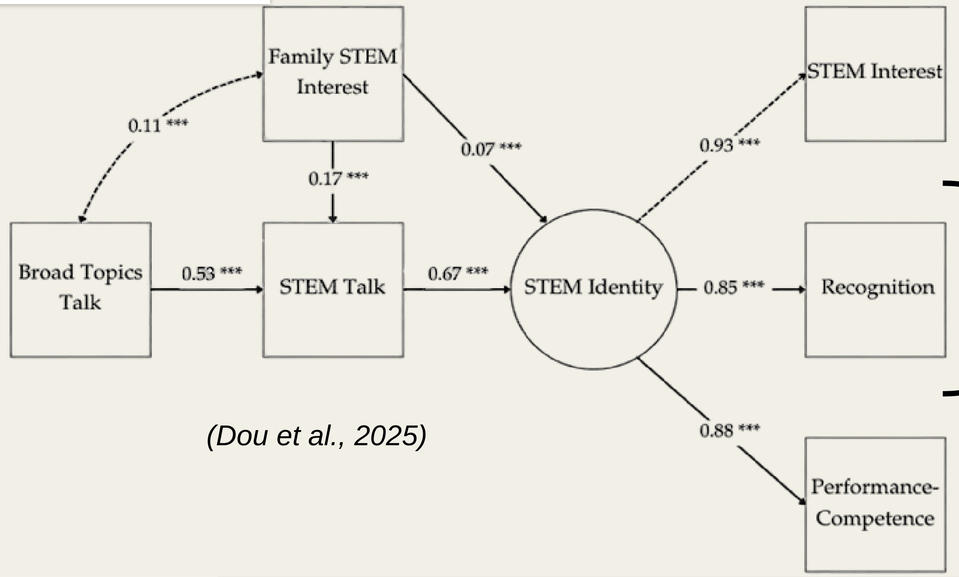
Survey

- Likert-scale
- Descriptive

- Caregivers
- Extended Family



- Family Interactions
- Informal Learning



(Dou et al., 2025)

- Teacher recommendation
- Called to answer STEM questions
- Getting accepted into a STEM program
- Receiving awards

(Awsaf et al., 2025)

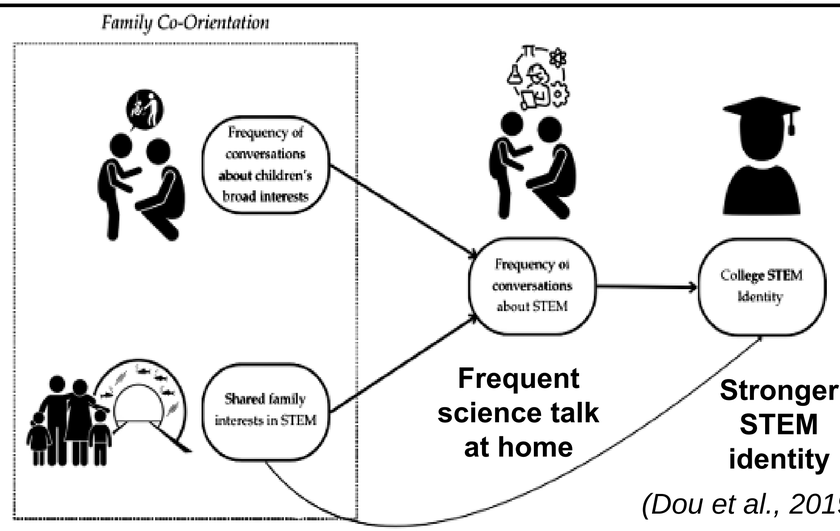
Family Interactions Lay the Foundation for Youth STEM Identity, Leading to Future STEM Success & Engagement

Family Interactions → **STEM Identity** → **STEM Engagement**

- **STEM Workforce participation**
- **Financial opportunities**
- **Civic engagement & action**
- **Self-directed learning**
- **Lifelong learning opportunities & hobbies**
- **Concern for the natural world**

(Dou & Cian, 2021)

Frequent Conversations about Broad Interests Spark Shared STEM Talk and Build a Strong STEM Identity



(Dou et al., 2019, 2025)

Dr. Remy Dou
Associate Professor,
University of Miami

Dr. Heidi Cian
STEM Education Specialist,
Maine Mathematics & Science Alliance

In 2025, ***Dr. Remy Dou*** received the prestigious ***Presidential Early Career Award for Scientists and Engineers (PECASE)*** for research on how everyday family STEM activities support children's STEM identity and socioemotional development, centering Latine voices as researchers, advisors, developers, and participants.

(CAREER - 1846167)

EXPERIENCING STEM FIRSTHAND

The Power of Connecting Schools and Local Industry

Megan C. Sharkey[1], Kristin Gagnier[1], Melissa Kurman[2], & Maya Heiland[2]. AnLar[1] & University City Science Center's FirstHand Program[2]

INTRODUCTION

Since 2009, informal science education has moved beyond one-time experiences to long-term, deep, equity-driven partnerships. Yet many innovators at the local level remain unrecognized (NASEM, 2025).

The FirstHand program aims to advance evidence-based STEM educational practices for students who attend under-resourced schools through inquiry-based, mentored experiences in an out-of-school laboratory setting located in West Philadelphia.

Participation Snapshot since 2014

- 2,100 students
- 18 avg hours/student
- 109 Philadelphia schools
- 348 STEM mentors
- 2,342 mentor hours

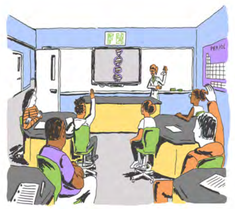
LEARNING THROUGH ECOSYSTEMS

FirstHand sits at the intersection of a vibrant Philadelphia learning ecosystem, linking public schools, and local STEM industries. Through these connections, the program:

- Cultivates students' mindsets, knowledge, and skills
- Engages hyper-local STEM professionals as mentors
- Supports equity in STEM education and careers
- Envisions a diverse STEM workforce

FirstHand is a bridge between Philadelphia's classrooms and thriving STEM industry through engaging students in real-world, hands-on science learning that strengthens and connects the city's STEM education and workplace ecosystems.

Under-Resourced Science Classroom



Innovation District + STEM Professionals

FirstHand Lab

Students immersed in 10-week, hands-on STEM experiences

TAKEAWAY 1

INFORMAL SCIENCE EDUCATION CAN BE DEEP, LONG-TERM, & RELATIONSHIP-DRIVEN

Deep:
FirstHand immerses students in interdisciplinary, real-world STEM projects (Figures 1 & 2). Students work in small teams, engage with scientific principles, and gain exposure to Philadelphia's thriving STEM industry, promoting authentic learning beyond the classroom.

Figure 1. FirstHand students present their final project, bioplastic glasses, to their community.

Figure 2. Students practice micropipetting before performing a DNA analysis lab.

Long-term:
Students engage in multi-week, hands-on programs with recurring mentorship from local STEM professionals (Figure 3), moving beyond the "one-and-done" model. Middle school programs are 10 weeks (2 hrs/wk) with 3 mentored sessions. High school programs are ≥8 weeks (2 hrs/wk) and are co-designed and co-facilitated by mentors. Mentored sessions include industry-relevant activities in the mentors' work spaces.

Figure 3. Mentors lead hands-on, industry-relevant activities to highlight day-to-day tasks in their careers.

Relationship-driven:
FirstHand fosters meaningful connections between students and adults, and multi-week programs culminate with a final project. Student teams, with support from their mentors and facilitators, brainstorm and prototype solutions for issues they identify in their communities. Students showcase their work to peers, families, school staff and community members, an empowering experience that builds confidence, ownership, and a sense of belonging in STEM (Figure 4).

Figure 4. Students present final projects at the student showcase.

TAKEAWAY 2

LEVERAGING RESEARCH PRACTICE PARTNERSHIPS (RPP) TO ADVANCE INFORMAL SCIENCE EDUCATION

FirstHand and AnLar's 6-year RPP supports continuous and systemic improvement and impact. Grounded in Henrick et al.'s (2017) five denominations of RPP effectiveness, our partnership:

1. **Builds trust and shared purpose** across researchers, practitioners, and community partners
2. **Conducts rigorous, timely research** aligned to the needs of students, educators, and the community
3. **Supports program development** by translating findings into actionable improvements
4. **Generates knowledge** to inform broader informal education and workforce ecosystems
5. **Builds capacity** for data-driven decision making

Our RPP leverages a multi-pronged research design to continuously improve the program and assess its impact:

- *Formative evaluation* explores the program's structure and provides actionable feedback
- *Implementation evaluation* examines how well the program's five core components are devleiered
- *Summative evaluation* examines the impact of participation on students' achievement in science and science identity.

Mixed Methods Data:

- Surveys of students' sense of belonging, self-efficacy, and valuing of science
- Observations of program using the STEM Program Quality Assessment (PQA; Figure 5)
- Interviews with all program stakeholders (students, teachers, caregivers, facilitators, mentors, industry leaders)

Supportive Environment
- Welcoming atmosphere
- Active participation
- Youth build skills
- Youth are encouraged

Interaction
- Partner with adults
- Collaborate with peers
- Lead & mentor
- Experience a sense of belonging

STEM PQA

STEM Skills
- Observe & measure
- Make predictions & test hypotheses
- Make connections across STEM
- Analyze &interpret data

Engagement
- Make choices
- Reflect
- Set goals & make plans

Figure 5. STEM PQA Framework adapted from Forum for Youth Investment (2015).

TAKEAWAY 3

INFORMAL LEARNING CAN INFORM AND SUPPORT FORMAL EDUCATION

FirstHand is a model for how informal learning can align with national and state science standards while meaningfully engaging students and the local STEM community.

Through sustained, real-world experiences, students develop knowledge, mindset, and collaborative skills that enhance their success in formal learning environments.

Informal education offers evidence-based models to make formal education more:

- Collaborative
- Learner-driven
- Inquiry-based
- Connected to students' communities and local industry

By bridging these worlds, programs like FirstHand have the potential to shift the culture of formal education, making it more relevant, equitable, and responsive to learners.

"It's a good place to step outside of your comfort zone, but it's a safe, sacred place kind of... where you can get away from school, it is kind of like school, but it's not because it's not graded"

"Science was not my best subject. But when I got to FirstHand, it was the best! It was very fun. It was hands-on. We don't really do that at school so that really changed my perspective"

"After being in the program, I've been getting better at science at school"

LEARN MORE

Learn more about how FirstHand and AnLar are redefining informal STEM learning, and what your community can do to build similar partnerships.

Forum for Youth Investment. (2015). STEM Youth Program Quality Assessment. David P. Weikart Center for Youth Program Quality. https://forumfyi.org/weikartcenter/assessments/

Henrick, E. C., Cobb, P., Penuel, W. R., Jackson, K., & Clark, T. (2017). Assessing research-practice partnerships: Five dimensions of effectiveness. William T. Grant Foundation. https://rpp.wtgrantfoundation.org/library/uploads/2017/10/Assessing-RPPs_Five-Dimensions-of-Effectiveness.pdf

This research is supported through an Education Innovation and Research (EIR) grant, which funds the development and evaluation of the FirstHand program to expand access to high-quality informal STEM learning experiences.

Extending Classrooms to Out-of-School Communities: Empowering Youth as Engineering Designers and Mentors

Dr. Hoda Ehsan, Director of Engineering and Design [1] & Founder [2]

Collaborators: Dr. Sareh Karami [3], Ms. Twila Fisher [1], Dr. Hossein Ebrahiminejad [2], Dr. Mehdi Ghahremani [3]

1 The Hill School, 2 ARTEC Pottstown Community MakerSpace, 3 Mississippi State University

Scan to connect

This 3-year project bridges formal and informal engineering learning to foster youth leadership in local and non-local communities. The vision is to move beyond seeing young people as passive learners and visitors, but as **creators, mentors, and changemakers** in STEM Education.

Cross-Sector Partnerships to Drive Impact

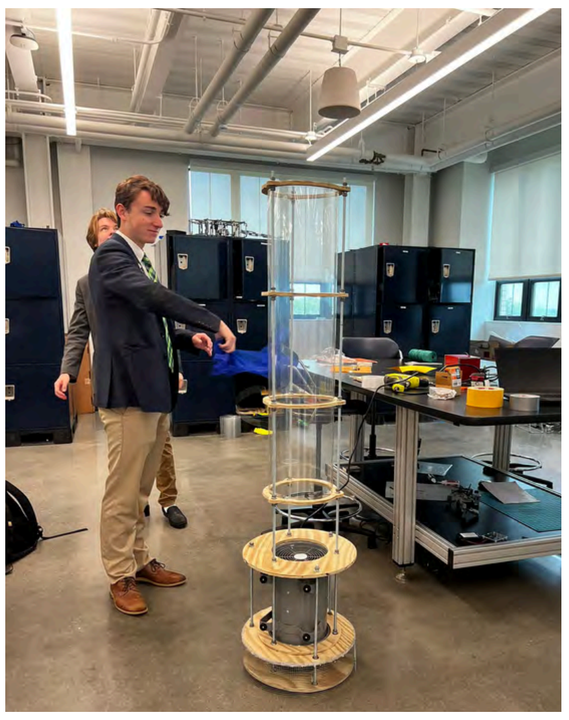
Bringing together schools, science centers, and makerspaces creates authentic, community-based STEM learning.

Youth as Teachers

Youth not only learn, but they teach, inspire, and lead, mentoring younger children through engineering camps and co-designed programs at makerspaces and community centers.

Youth as Exhibit Designers

Youth applied their engineering and making skills to design STEAM and social sciences exhibits and tools for science centers, contributing to and shaping the field of informal education.



FROM COLLEAGUES TO CATALYSTS:
THE POWER OF COHORT-BASED STEM PROFESSIONAL LEARNING IN INFORMAL SPACES

Kate Kogge, M.Ed.
Svea Anderson, M.Ed.
STEM Education Specialists,
Griffiss Institute
Contracted to the Air Force Office of Scientific Research (AFOSR)

Overview

Launched in 2023, the **STEM Teacher Leadership Academy** (**STLA**) is a cohort-based, week-long summer program for K-12 STEM educators in the National Capital Region (NCR). Hosted at the Smithsonian's National Air and Space Museum, STLA connects teachers to cutting-edge basic science research supported by the Air Force Office of Scientific Research (AFOSR).

Each year, 20 talented educators work with subject-matter experts to explore AFOSR's research portfolios - including *Natural Materials & Systems* and *Cognitive and Computational Neuroscience* - and discover how this research can be translated into powerful classroom learning.

The 2024 STLA cohort at the National Air and Space Museum in Washington, D.C.

Objectives

Bridge the Gap Between Basic Science Research and the Classroom
Empower teachers to translate complex scientific concepts into engaging, standards-aligned STEM lessons that are accessible to students of all grade levels.

Foster a Cohort-Based Professional Learning Model
Build a supportive community of practice where educators collaborate, reflect, and grow together, both during the program and beyond.

Cultivate Teacher Leadership and Mentorship
Develop educator-leaders who not only apply what they've learned in their classrooms, but also mentor peers and expand STEM impact in their schools and districts.

Support Long-Term Educator Engagement and Impact
Encourage sustained professional development by engaging returning mentor teachers, supporting ongoing community engagement, and fostering a pipeline of STEM talent in the NCR through a year-long lending library program.


2023 STLA cohort members in a hypersonics workshop with the Joint Hypersonics Transition Office

"My STLA journey is a continuum. I am looking forward to being a mentor for the second time. My goal is to emphasize the importance of what can be, explore the tools and technology, and then figure out ways we can impact our classrooms in astronomical ways."

-Melissa Green, 2023 STLA cohort participant and 2024/2025 STLA Mentor

Results

Educator Impact:

- **60+** K-12 STEM educators trained since 2023
- **100%** reported confidence in sharing basic science research with their K-12 students
- **82%** rated the program as "Outstanding"
- **4** mentor teachers selected to lead new cohorts

Strengthened Partnerships:

- **National Air and Space Museum**
- **National Museum of Natural History**
- **International Spy Museum**
- **U.S. Botanic Garden**
- **CodeVA**
- **National Reconnaisance Office**
- **Joint Hypersonics Transition Office**
- **Griffiss Institute**
- **Over a dozen affiliated universities**


2024 STLA cohort members and mentors examining the Q?rius exhibit at the National Museum of Natural History in Washington, D.C.

Key Takeaways

Cohort-Based Learning Deepens Understanding of Basic Science Research
STLA's collaborative model empowers educators to explore AFOSR's foundational research portfolios through shared inquiry and discussion. Working in a cohort helps participants process complex scientific concepts together and identify meaningful ways to translate them for K-12 students.

Educators Become Translators of AFOSR Research for the Next Generation
Through immersive, research-connected experiences, cohort members learn to bridge the gap between cutting-edge basic science and classroom instruction. This supports AFOSR's broader mission by cultivating a pipeline of scientifically literate students and inspiring future STEM innovators.

Cohort Continuity Builds a Network of STEM Leaders Aligned with National Priorities
By fostering returning mentors and sustained peer relationships, STLA develops a leadership community that amplifies the impact of AFOSR's investments in science. These educators serve as ambassadors of basic research, reinforcing its importance in classrooms and school systems across the National Capital Region.

From Drivers of Wonder to Defenders of Truth: ISE in Times of Science Denial

Josh Gutwill and Sue Allen, Clean Conferencing Institute

ISE has **advanced** STEM Education

Over the past 15 years, ISE has helped **develop and disseminate critically important concepts** in STEM education:

- Culturally responsive dialogues
  - From Transmission to Transformation
- Science Capital and Identity
  - Belonging and social factors
- Equity-Oriented Design
  - Equity Compass
  - REVISE
  - Culturally Responsive Engagement
  - EDGE
- Public Engagement with Science
  - Rapid response programming
  - Evidence-based thinking
  - Civic dialogues

ISE created resources and toolkits

- NISE Network made complex science accessible through hands-on activities, dialogue guides, and facilitator training grounded in social context.
  - Climate toolkit
  - COVID Engagement toolkit
  - Nano toolkit
- ASTC and AAAS supported science learning through empathy, values framing, and evidence-based decision-making
- InformalScience.org, CAISE and REVISE created a platform for sharing evaluation tools, project models, and equity-based research

Evaluation and Learning Advances

- ISE focused on meaning-making, trust-building, engagement, identity, belonging, and science agency
- Embraced new methods: participatory, culturally responsive, shared instruments

But an **unprecedented assault** is underway

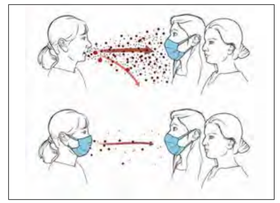
Landscape of suppression

- Climate denial and disinformation
- Medical disinformation
- Attacks on public education
- Defunding of research and education
- What makes this moment different
- The scale: Misinformation spreads globally in minutes
- The stakes: Preventable disease outbreaks, stalled climate action, erosion of public trust in science and institutions
- The strategy: Disinformation is targeted, emotionally resonant, and aligned with suppression campaigns

Why ISE must respond

- Trusted messengers of science
- Place-based and hyperlocal
- Positioned between science and society, interpreting scientific concepts AND bringing values like inquiry, uncertainty, ethics, and collective action

ISE has **fought denial and disinformation** before



KQED, Texas Tech & Rockman's Rapid Media Project developed and tested new approaches for educating millennials about the science behind COVID-19.

"Project Vaccine: Our Best Defense," an exhibit at the Museum of Science, used hands-on activities and presentations to reduce vaccine hesitancy.

The U.S. Botanic Gardens created Plants and Climate Change Education (PLACCE) to develop and test plant-centered climate change education models.

The Climate Change Wall at AMNH evolves over time, bringing in current disasters and data on climate.

What's next — How can the ISE field lead?

Focus ISE networks on combatting disinformation

- NISENet
- STEM Ecosystems
- NNOCCI

Launch *visible* truth campaigns

- "Vaccines save lives"
- "The Earth is getting hotter"
- Window displays
- Billboards
- Exhibitions

Partner with policy advocates

- Union of Concerned Scientists
- 350.org
- Citizens' Climate Lobby
- March for Science
- Third Act

Program for rapid-response

- Social media posts & reposts
- Community conversations
- Expert panels
- Educator briefings

Activate civic science

- Provide postcards, QR codes, scripts to contact elected officials
- Encourage voting
- Publicize important school board meetings

Rethink sponsorship

- Exclude sponsors & donors who fund science denial, fossil fuel disinformation, or anti-public health efforts
- Publicize the policy

From Local to Global: Finding Shared Values & Success in the Youth Climate Summit Model Around the World

Jen Kretser, Director of Climate Initiatives, The Wild Center, jkretser@wildcenter.org - Frank Niepold, Senior Climate Education and Workforce Program Manager, NOAA Climate Program Office, frank.niepold@noaa.gov

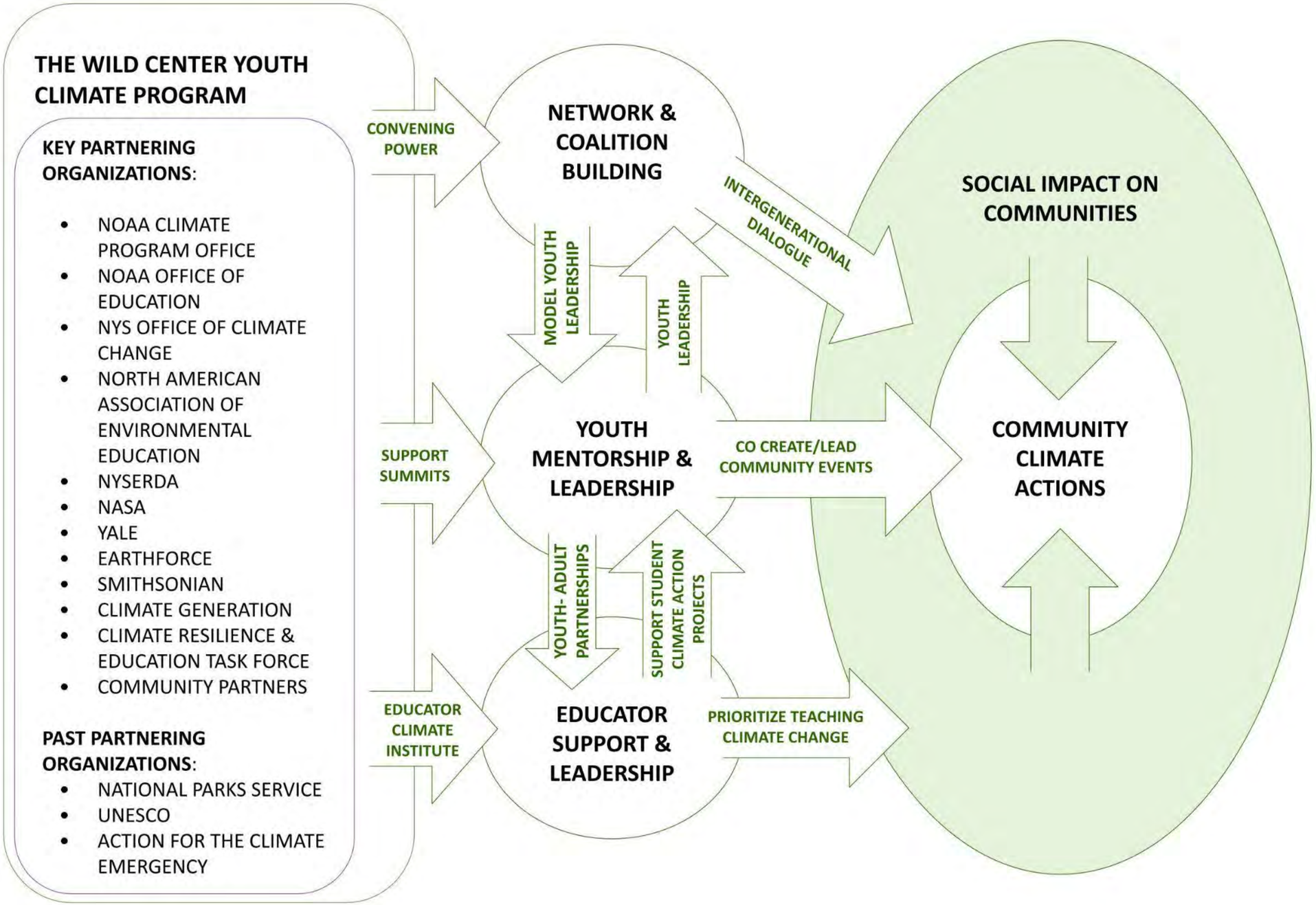
The Wild Center's mission is to ignite an enduring passion for nature that inspires action to to ensure a thriving natural world. We are science center located in the Adirondack Park of New York State.

- The Wild Center's **Youth Climate Program** is a global initiative that convenes, educates and empowers young people to act on climate change through **Youth Climate Summits model**.

- The Summit culminates with students creating a student-driven **Climate Action Plan** that they implement in their school and/ or community.

- To fully support youth leaders agency, multiply entry points such as leadership development and teacher support, needed to be developed and linked into a more robust learning system to catalyze community climate action to ensure a thriving world. (See the diagram to the right.)

Note: This program was supported by NOAA's Environmental Literacy Program and numerous other funders and partners.



https://www.wildcenter.org/our-work/youth-climate-program/

High School Science Fair: What Students Say – Mastery, Performance, and Self-Determination Theory

Frederick Grinnell*, Simon Dalley**, & Joan Reisch*
UT Southwestern Medical Center* & Southern Methodist University**

The Question- Most high school students indicate that participation in science and engineering fairs (SEFs) increased their interest in science and engineering (S&E). The underlying appeal of SEF participation is unknown. Having this information will help to identify best practices leading to more effective student participation and successful outcomes.

New Findings- In our latest work[1], we report and analyze the positive and negative comments by 1191 students who participated in our surveys during 2021-22 and 2022-23 and provided free text reasons why SEF participation increased or not their interest in S&E (Figure 1). Reasons students gave why SEF participation increased their interest in S&E aligned with mastery criteria. By contrast, reasons students gave in a previous study regarding why competitive SEFs should be required or not aligned with performance criteria[2].

Self-determination Theory- Mastery and performance orientations (learning vs. winning) integrate differently with the three elements of self-determination theory: motivation, competence and community engagement. Mastery more closely aligns with intrinsic motivation and demonstrating competence but not necessarily with community engagement. Performance more closely aligns with extrinsic motivation, demonstrating competence, and enhanced community engagement.

Refs: 1. PLOS ONE, In Press; 2. PLOS ONE. 2020;15(2):e0229237.

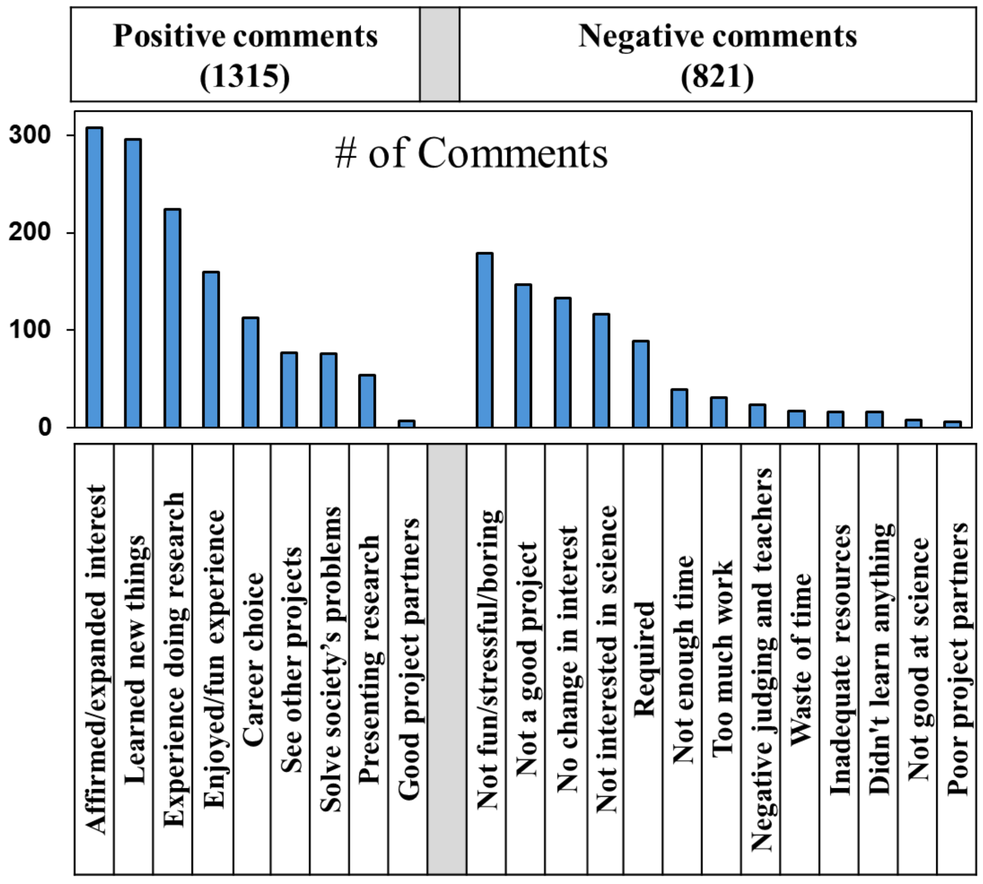


Figure 1. Students' comments in answer to the question why SEF participation increased or not their interests in S&E.

Student Experience- Overall, more than half the students (61.6%) made positive comments about why SEF participation increased their interest in S&E but with important nuances. Students making the most positive comments were those:

- Interested in a S&E career.
- Who chose rather than were required to participate in SEFs.
- Who received coaching for the SEF interview.
- Who had help from scientists.
- Who participated in SEFs beyond the school only level.

Demographics- Students in 11th and 12th grades made more positive comments compared to students in 9th and 10th grades.

- Asian and Hispanic students made more positive comments (72.6% & 69%) compared to Black and White students (54.7% & 51.6%).
- No gender differences were observed.

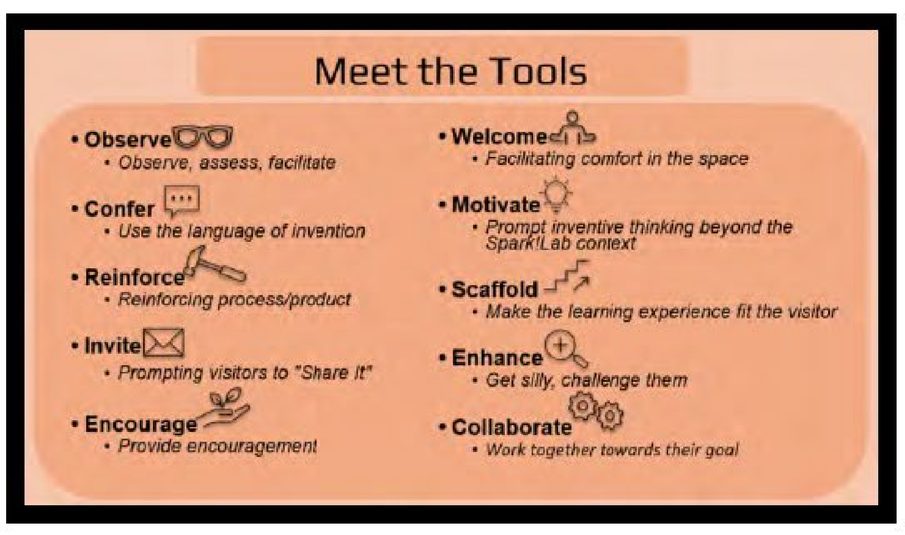
Key Takeaway -- Understood in the context of mastery and performance goals and the framework of self-determination theory, science and engineering fairs can support both objectives of STEM education -- science for everyone and science for the scientists and engineers of the future.

Inventive Identity Exploration in Informal Science and Engineering

(1) We use the Dynamic Systems Model of Role Identity (DSMRI) to conceptualize inventive identity.

(2) The DSMRI was integrated with exhibition design principles for promoting visitors' learning and identity exploration.

(3) Visitors explore inventiveness in facilitated and unfacilitated contexts at the National Museum of American History in Washington, DC.



(4) Our Facilitator Inventive Identity Toolkit applies the DSMRI to support visitors' inventive identity exploration.

WONDER
Jazz music transforms science from a subject into an experience.

AGENCY
Lab coats, real instruments, and creative challenges let students lead—not just participate—in their learning.

BELONGING
Representation, respect, and relevance are built into every moment.

POSSIBILITY
Deliberately designed as a space for "yes," Jazz Lab™ empowers students to expand what's possible within themselves.

JAZZ LAB™ MOBILE

Remixing STEM Access for What's Next

At its core, **Jazz Lab™ Mobile is an equity engine**—reaching students in historically marginalized communities who may never walk into a science museum or coding bootcamp. This **mobile STEAM model** smashes barriers like **cost, transportation,** and **exclusion**—replacing them with **access, opportunity**, and **trust**.

BY THE NUMBERS

Live Jazz Strikes a Chord

Over 87% of students gave high marks to the **live jazz experience**—many encountering **real instruments for the first time** during Sound Science week.

EXPANDING ACCESS WHERE IT COUNTS

- From **11 afterschool sites** to **COSI STEAM Fest**, Jazz Lab™ brings learning to **where kids already are.**
- **95% completion rate**—that's **5 hours of hands-on STEM activities**, delivered **where it's needed most.**
- **70%+ of participants** come from **Title I schools**.
- Student demographics: **55% Black/African American, 30% White, 10% Latino/Hispanic, 5% East African (primarily Ethiopian and Somali)**—communities historically underrepresented in STEM.
- **50% girls participated—bridging gender gaps** in tech and science.
- In its pilot year, Jazz Lab™ reached **468 students** — **181 at afterschool sites** and over **300 at festivals and workshops.**

JAZZ LAB™ RUNS ON COLLABORATION

Funded by **Battelle** and supported by **Columbus Recreation and Parks, COSI,** and the **PAST Foundation,** we unite schools, artists, and engineers to deliver bold, equitable STEAM learning.

ABOUT JAZZ LAB™ MOBILE

Jazz Lab™ Mobile brings STEM to life through the lens of jazz—blending music, science, tech, and creativity in an out-of-school-time experience.

Designed for **youth ages 7–14**, the **four-week program** delivers hands-on exploration of **sound science, instrument anatomy, rhythm activities, synthesizers, VR,** and **DIY builds.**

Every session **centers curiosity, collaboration, and improvisation**—helping students build **creative confidence, problem-solving skills, and resilience.**

In Jazz Lab™ **adapting on the fly** and **spotting patterns** aren't just jazz skills—they're **essential STEM competencies for tomorrow.**

PROGRAM HIGHLIGHTS

In Jazz Lab™, everything starts with the music—it's the spark that gets neurons firing and bodies moving. A jazz trio —equal parts **musicians** and **educators**—brings each session to life with **sound, science**, and **culturally rich learning.**


Live Jazz Music
All Four Weeks


Week One
Sound Science


Week Two
Synthesizers

Week Three
Virtual Reality


Week Four
Instrument Assembly

Scan for a special look at Jazz Lab™

CHECKING THE BOXES

Jazz Lab™ Is...

- **Immersive**
- **Hands-on**
- **High Engagement**
- **Collaborative**
- **Adaptable** (fits any space—gym, library, cafeteria)
- **Interdisciplinary** (blending music, science, tech, and culture)
- **Multiple Learning Modalities** (auditory, visual, kinesthetic)
- **21st Century + Social-Emotional Skills Building**

A TRIBE FOR JAZZ is a 501 (c)(3) nonprofit whose mission is to preserve the legacy and advance the future of jazz through visual storytelling, live and virtual performances, education, and community engagement.

STEPHANIE MATTHEWS | EXECUTIVE DIRECTOR
Smatthews@atribeforjazz.org | (917) 858-9453
www.atribeforjazz.org

Leading with the Arts:
Centering Arts-Based Methods for Deeper Science Learning

The expertise, practices, and skillsets of artistic disciplines can enhance science learning.
Not by using them as a "hook" for STEM activities, but leveraging their distinctive assets to further learning.

1 **Visual arts educators have spent decades supporting learners to make sense of dense, designed, visual materials. The arts is adept at building skills of looking needed for data literacy.**

2 **Dancers embody their roles, activating cognitive, affective, and empathetic learning. By experiencing concepts, feelings, and players in a science story, learning is deeper.**

3 **Collaboration with theater artists enables new forms of scientific storytelling and sense-making for audiences. Centering the humanity of scientific research opens possibilities.**

Visual Arts & Data Literacy: Building Insights through Observation

Co-PI: Jessica Sickler (J. Sickler Consulting)
PI: Dr. Kathryn Semmens (Nurture Nature Center)

Project Theory & Goal

Visual thinking and design thinking, alongside content understanding, are fundamental skills for literate data consumers.
Research Question: Which data literacy skills are most strengthened through the use of visual arts-based teaching practices?

The BIO Teaching Approach

1 Observe & Discuss: Art + Data

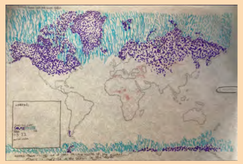
VTS-inspired discussions – of art and data - about a core topic.

2 Bridging: Data & Symbols

Each person answers a poll with symbols. Lined up, individual responses reveal visual patterns

3 Designing: Data Sketches

Participants visualize geospatial datasets on tracing paper. Layered sketches reveal correlations.



Key Findings: Data Literacy Improvements

- Greater growth in making claims with data and supporting with evidence
- Greater number and diversity of observations made about a dataset
- More engagement – and from more diverse learners
- Teachers saw increased visual literacy and critical thinking about data
- Science educators saw more value in using the arts in science

"I learned that there's always more than meets the eye with some of this data. There are hidden correlations that sometimes you don't see. I did learn to open up and try to find more correlations between stuff."

This material is based upon work supported by the National Science Foundation under Grant No. 2101310. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Dance & Sea Turtle Conservation: Communicating Science through Dance

PI: Dr. Lekelia "Kiki" Jenkins (Arizona State University)

Project Goal

Experimental research to understand the potential of *SciDance* for informal learning, compared to "business as usual" science communication.
Research Question: How does creating and participating in dance as a form of storytelling impact participants' understanding of, empathy towards, and behaviors towards sea turtle conservation?

The SciDance Program

1. Attend a Science Cafe style talk about sea turtle research and conservation efforts
2. Engage in guided co-creation of dance choreography with SciDance facilitators, including warm-up activities
3. Perform dance expressing key themes and characters from the research talk.

NOTE: The dance group was randomly selected from all study participants. The control group experienced only the Science Cafe talk portion.

Key Findings: Participant Outcomes

- Greater sense of togetherness and community (with strangers)
- Greater sense of peace and tranquility
- Lower feelings of tension
- Greater perspective-taking: imagining feelings and experiences of sea turtles
- Greater hope, compassion, and concern for the well-being of turtles
- Recall more and more diverse themes about the science

"We had to feel what it felt like to be captured and chased and trapped–it wasn't fun. I feel like I learned more through the dance portion because I had to be empathetic towards the sea turtles because I was caught in that position and playing that role."

This material is based upon work supported by the National Geographic Society under Grant No. 59127R-19. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Geographic Society.

Theater & Astrophysics: Microcosms at AMNH

PI: Dr. Ruth Angus (American Museum of Natural History)

Project Goals & Motivations

- To create new works that disseminate scientific and cultural aspects of astrophysics via theatrical storytelling
- To foster a community of cross-disciplinary collaborators
- To learn how to bring scientists and artists together to make stuff

The Collaboration

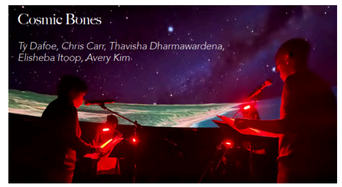
This was a collaboration between AMNH and the Public Theater that highlighted the work of the Vera C. Rubin Observatory.

Three-hour workshops ran for 10 months between March and December 2023.

Significant time was spent between artists and astrophysicists devising prompts, co-writing, discussions, research, guest speakers, social events, and more.

Rehearsals culminated in a live public performance in the Hayden Planetarium (December 2023)

THE PUBLIC®
American Museum of Natural History



Results and Next Steps

- 4 new works performed in the Hayden Planetarium
- Very different styles and approaches
- High audience satisfaction
- 1 group *still* working together on art-science projects
- 1 astrophysicist applying to art school
- Reflecting on process and priorities

This material is based upon work supported by the National Science Foundation under Grant No. 2108251. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Learning Ecosystems Northeast

Building Data and Climate Literacy by Connecting Learning Across Informal and Formal Learning Environments

Principal Investigator: Leigh Peake, GMRI

Gulf of Maine Research Institute

Key Takeaways

1. Diving into research and practice around learning ecosystems* allowed us to **decenter ourselves** and our institution.
2. Decentering ourselves transformed our understanding of our role and **centered the importance of relationships** with other organizations.
3. Centering relationships with others highlighted the need for entirely **different metrics for success.**

* E.g., Hecht & Crowley, 2019; Ching et al., 2018; Bronfenbrenner, 1977; Peneul et al., 2014; Santo, 2019; Barron 2006.

Foundational Principles

- Youth need as many entry points into STEM as possible.
- In order to enrich learning pathways for youth, the adults surrounding those youth need increased opportunities to connect, collaborate, and learn.
- As teachers, librarians, and out-of-school educators interact with youth, we have the opportunity to connect learning experiences – to "broker" learning.
- By braiding diverse knowledge and perspectives into learning, we will do a better job serving all youth; build better, more resilient communities; and make better science.
- We focus on place-based climate change education because it is compelling to youth and provides unique affordances for building critical lifelong STEM skills, specifically data and modeling.
- NASA supports and believes in this work as a way to ensure communities see the relevance of NASA's global scientific program to their local priorities.

Activating Local Learning Ecosystems

Schools supported to connect local ecosystems to global climate change through authentic data

Community institutions supported to provide data-rich climate resources and experiences

Informal learning spaces like LabVenture ignite interest and prepare youth for future learning

Formal

CURRICULUM
Classroom materials help teachers build students' data and climate literacy through local ecosystem explorations.

TEACHER PROFESSIONAL DEVELOPMENT
Teacher professional learning experiences support development of teachers' content knowledge and comfort teaching data literacy concepts.

COMMUNITY SCIENCE
Community Science investigations designed for use inside the classroom or out allow students, citizens, and scientists to collaborate in investigating local ecosystems.

FIELD NOTEBOOK
The Notebook launched during LabVenture connects learning across informal and formal environments and evolves to become students' representation of themselves as a scientist.

TOOLS
CODAPs data analysis and representation tools are designed specifically for use in classrooms and allow students to explore climate data from both NASA and local sources.

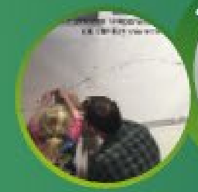
Informal

SCIENCE CENTERS/MUSEUMS
Data-rich climate engagements at science centers enrich and enhance school-based learning experiences.

4H
4H programs provide exploration of climate impacts on agriculture connected to school-based learning experiences.

Public Engagement

SCIENCE CENTERS/MUSEUMS
Hands-on climate exhibits designed specifically for visitors to regional science and technology centers feature localized explorations powered by NASA data.



MODELING CHANGE
An adult version of the LabVenture experience allows visitors to GMRI to use NASA data to explore the impacts of warming oceans in the Gulf of Maine.

COMMUNITY SCIENCE
Community science investigations designed for use inside the classroom or out allow students, citizens, and scientists to collaborate in investigating local ecosystems.

LAND TRUSTS
Land trust educators provide locations and expertise to enrich school-based field science experiences.

LABVENTURE
More than 70% of Maine's 5th/6th grade cohort annually use NASA data to launch investigations of the impact of warming oceans on the Gulf of Maine ecosystem.

LIBRARIES
Programs and community science experiences hosted by libraries allow youth another pathway to explore local ecosystems and capitalize on the emergence of libraries as community-based hubs for STEM.

Project partners

The University of Maine Cooperative Extension

Maine.gov/nsl Maine State Library

Sciencenter

Gateway Community Services Maine

MWOBS Mount Washington Observatory

Wabanaki Youth in Science

EDC Education Development Center

Stanford University

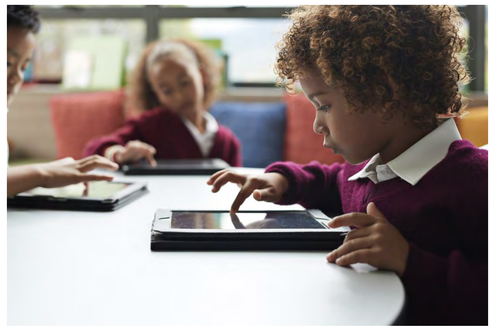
NASA Award Number: NNX16AB94A

Lessons Learned from Black families as Partners in Community STEAM Learning`

DeLean Tolbert Smith, PhD (dtolbert@umich.edu)
Department of Industrial and Manufacturing Systems Engineering, College of Engineering and Computer Science University of Michigan - Dearborn

Lesson #1: When families use familiar, accessible technologies, they dive deeper into STEAM learning within their own contexts and create compelling data from their unique viewpoints.

Lesson #2: Building genuine relationships with community organizations who are connected to, serve and inspired by families is critical to impact



This project is funded by the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Measuring What Matters:

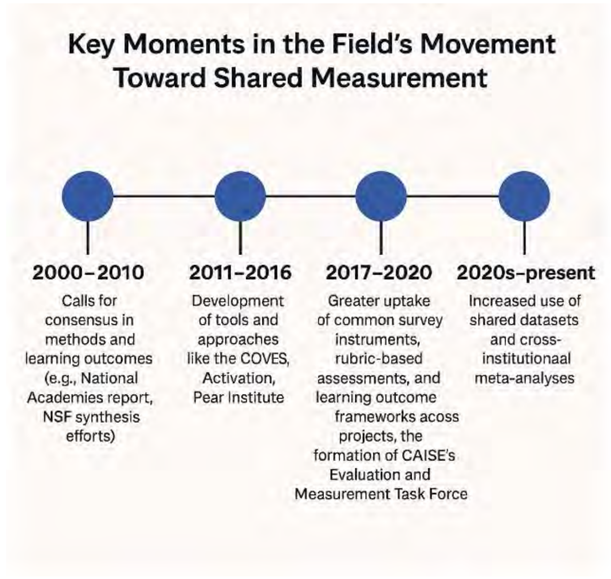
Shared Metrics and Impact in Informal Science & Engineering Education

Rena Dorph & Mac Cannady
Lawrence Hall of Science, University of California, Berkeley

The Lawrence Hall of Science
UNIVERSITY OF CALIFORNIA, BERKELEY

Emergence of Shared Measurement Tools

Over the past 15 years, the informal science and engineering education field has evolved from a patchwork of individual projects and evaluations to a more connected landscape, where shared measurement tools and frameworks allow us to tell bigger, collective stories of impact.



Some Examples

The Learning Activation Lab is a national research and design effort to dramatically strengthen learning in the United States and beyond. It offers a suite of tools to measure the disposition, skills, and knowledge that position individuals for success in learning. Efforts are ongoing to create a robust data platform to allow for comparisons across users of the tools.

The Collaboration for Ongoing Visitor Experience Studies (COVES) is designed to unite museums across the country to systematically collect, analyze, and report on visitor experience data. As of January 2025, COVES members include 112 participating institutions that identify as: 31 science centers, children's museums, natural history museums, and history museums; 11 art museums; and of 70 art museums.

The PEAR Center provides research-backed assessment tools that go beyond static reports—they deliver living data that educators and program leaders can use right now to support every student. Their assessments measure youth resilience and STEM engagement, offering programs with real-time, individual-level insights to understand each child's strengths and challenges.

New Insights and Opportunities

- Field-wide data shows how informal science learning experiences advance science identity, interest, and confidence, especially for underrepresented groups
- Cross-project analyses reveal long-term impacts that no single program could capture on its own
- Shared metrics support advocacy and funding, providing evidence for the societal value of informal STEM learning
- The field needs to rally together to respond to the moment

Looking Forward…

For Researchers: Contribute to and use shared datasets
For Practitioners: Align your evaluation with common frameworks
For Funders: Support initiatives that advance collective learning

The Lawrence Hall of Science is building a data platform to support stronger, evidence-based case for the transformative power of informal science and engineering education. Join us.

Reach Out

https://lawrencehallofscience.org/
Rena Dorph, PhD
Director
Lawrence Hall of Science

Museum Experiences for Science Teachers

Since *Learning Science in Informal Settings*[1], we've learned...

Ammonite on display at the Smithsonian National Museum of Natural History

1. **Museums are critical, unique sites for science teacher learning.**

2. **School, museum, and university partnerships foster innovation in science teacher education.**

3. **Design frameworks are needed to help teachers bridge between classroom and museum learning.**

Examples

About the Authors

Tiffany-Rose Sikorski, Associate Professor at George Washington University, and **Matty Lau,** Founder of the Teacher Learning Consultancy, have designed and studied museum experiences for STEM teachers. They are both former 8-12 grade physics teachers with experience teaching in museums.

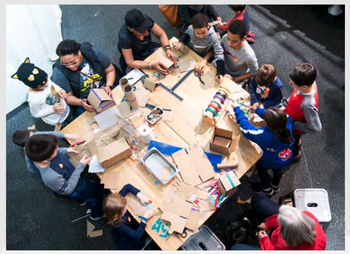
[1] National Research Council. 2009. *Learning Science in Informal Environments: People, Places, and Pursuits.* Washington, DC: The National Academies Press.

This material is based upon work supported by the National Science Foundation under Grant Nos. (1238157) and (1439819), and 100Kin10. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation or 100Kin10.

Museums and Science Centers as Drivers of Innovation in Research and Practice

Suzy Letourneau, Katherine McMillan Culp, Laycca Umer · *New York Hall of Science*

Research teams embedded within museums and science centers work in close collaboration with multiple stakeholders within and beyond their own institutions. These in-house teams can investigate urgent problems of practice, design and study new forms of informal STEM learning, and advance knowledge about how to engage and support broad and diverse groups of free-choice learners. This poster celebrates the collaborative, often under-recognized work of research teams housed in informal learning institutions. It also highlights the variety and impact of recent research-practice collaborations at the New York Hall of Science.



In a research-practice initiative funded by an NSF CAREER award, a cross-departmental group of museum staff is critically examining the features of science exhibits that support or hinder families' agency as learners. Research studies are using intersectionality and cultural historical activity theory as analytical lenses, and the group is co-creating practical tools to help museum staff notice and support agency for the broadest possible audience. *(NSF DRL grant 2046141)*

In a three-year project, activity developers, facilitators, and researchers from NYSCI, the Scott Family Amazeum, and the Tech Interactive added narrative elements like characters, settings, and compelling problems to six engineering design activities and compared them with non-narrative versions. The study found that girls stayed longer and used more engineering practices when activities included narratives. The project resulted in a guidebook to help informal STEM educators add narratives to existing activities. *(NSF DRL grant 1712803)*

Building Museum-based Learning Communities

At NYSCI, researchers are full-time staff, and study teams include professionals with diverse forms of expertise — including educators, designers, facilitators, visitors, community members, and researchers.

Roles within these projects expand beyond the binary of research and practice, as teams establish learning communities with shared questions and complementary knowledge and ways of working.

Our efforts are informed by similar models at multiple peer institutions, including the Exploratorium, Science Museum of Minnesota, Museum of Science Boston, and Center of Science and Industry. The ongoing work of these museum-based communities has resulted in practical strategies for supporting science and engineering learning at scale.

Valuing Intersectional Identities and Perspectives

Research at NYSCI is using intersectionality as a lens to investigate how systems and practices in informal learning environments lead to inequitable experiences across multiple dimensions of identity.

Our approach to multi-stakeholder research frames the complexity of our audiences and our project teams as an asset in our efforts to create learning experiences that are broadly engaging and relevant to as many people as possible.

Considering multiple identities that learners hold at the individual, family, and community level, as well as the ways that our identities shift across contexts in response to social norms and expectations, can only strengthen our work.

Collaborating for Local Relevance and Fieldwide Impact

The presence of multiple perspectives and priorities within study teams creates productive pressure to ensure that the knowledge and resources produced are locally relevant, adaptable, and potentially scalable.

This view of the goals of research has facilitated a shift toward participatory forms of research that include various audiences as partners with unique knowledge of their communities.

Collaborating locally also benefits broader audiences, as institutions form partnerships and networks to explore questions and develop solutions with input from various communities with distinct strengths and needs.

Museum staff collaborated with two cohorts of youth Explainers between 2018-2020 to create museum activities based on "engineering habits of mind" identified by professional engineers. By exploring engineering as a way of thinking, the project shifted how Explainers interacted with visitors, encouraging them to explore their own questions and interests. *(NSF DRL grant 1634069)*

Two postdoctoral fellows are working in residence at NYSCI to collaborate with museum staff and community members. The fellowship is preparing early career researchers to conduct practice-driven and equity-oriented research in informal settings. *(NSF DGE grant 2329473)*

In a three-year project, museum staff from NYSCI, Children's Museum of Pittsburgh, and Explora are partnering with autistic youth to develop and improve engineering design activities. Teams are using Universal Design for Learning to explore whether and how creating activities with the needs of autistic learners in mind can result in strategies that support belongingness and engineering learning for all visitors. *(NSF DRL grant 2313850)*

Two recent co-design projects at NYSCI explored family engagement in partnership with caregivers. One project brought together caregivers of young children, pre-K teachers, museum educators and researchers to brainstorm new directions for family engagement programs at the museum.

A second project involves co-design of new evaluation tools for family programs. Together, these projects have used intersectional approaches to examine how museums can support the many roles and identities that caregivers take on in informal learning environments.

(NSF DRL grants 2215353; 2415503)

This material is based upon work supported by the U.S. National Science Foundation under grant numbers 1634069; 1712803; 2046141; 2215353; 2313850; 2329473; and 2415503. Any opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

nysci DESIGN MAKE PLAY · New York Hall of Science

NASA GLOBE Goes to Camp

Impacting Informal Environmental Education

Tina Harte Ballinger - Lead (NASA Langley), Phillip Potter (Wisconsin Lions Camp), Mike Shanahan (Shady Creek Outdoor Ed Center), Amy Ellisor (NASA DISCOVERIES)

Overview

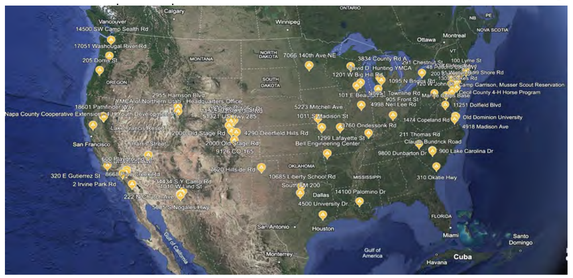
- The NASA GLOBE Goes to Camp Project is an environmental citizen science project aligned with NASA Earth Science Missions and incorporates GLOBE data collection. It has been funded under the NASA Science Activation Award No. NNX16AE28A – NASA Earth Science Education Collaborative (NESEC).
- The NASA GLOBE Goes to Camp Pilot was initiated in 2019 with three summer camps (IL, SC, VA). From 2019 to 2025, over 72 camps from 25 states have incorporated the NASA GLOBE Camp Project into their camp programming, impacting over 75K learners (ages 3-99) and their families.
- As a component of the project our curriculum developers created ten informal NASA GLOBE Camp Learning Guides, four of which can be viewed on the GLOBE Observer Website. The remaining guides will be coming soon to the NASA Langley GLOBE Resource page.

Goals

- Establish a network of NASA GLOBE Camps across the United States to cultivate a sense of environmental stewardship through engaging in NASA citizen science with NASA and GLOBE.
- Empower learners of all ages through NASA citizen science STEAM focused explorations within a community-based learning ecosystem addressing real-world environmental issues.[1]
- Increase learners' interest, self-efficacy, and awareness of careers within the field of STEM.[2]
- Advance Earth system science through data collection and analysis while building skills in STEM, data literacy, critical thinking and problem solving.
- Develop informal environmental education learning guides building upon elements of NASA Earth Science Missions, GLOBE, and Environmental Education Best Practice Research.[3]

Partners

- Through sharing the NASA GLOBE Goes to Camp Project during camp related conferences, newsletters, and trainings we were able to share information regarding the project with camp directors from across the United States.
- Each year we shared a google form application by which camps applied to be part of the NASA GLOBE Camp Network.
- Once applications were received, individual meetings were scheduled to discuss how the project might fit best with each individual camp. Once the implementation plan was organized, camp directors were given the opportunity to attend GLOBE Protocol/Learning Activity Trainings to prepare for their summer camps.
- Throughout the project we have worked with a variety of summer camps including Girl Scout, 4-H, YMCA, Outdoor Education Centers, Kiwanis, Park and Rec Centers, Audubon Society, Youth Alliance, Special Needs, and STEM Camps.
- Each camp brings a unique aspect to our NASA GLOBE Camp Network where we all learn from each other making a difference one camper, one camp, at a time.

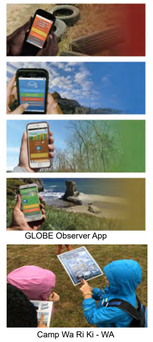


2019-2025: Locations of 72 camps that have incorporated GLOBE Goes to Camp into their programs

Implementation

Informal Learning Guides

- The initial four informal learning guides developed for camps were aligned with the four tools on the GLOBE Observer app (Clouds, Land Cover, Mosquito Habitat Mapper, and Trees) providing camps and outdoor education centers a user-friendly tool for data collection.
- Each learning guide incorporated a GLOBE protocol, associated data sheets, supporting learning activities, journal prompts, the "NASA Why", Next Generation Science and Engineering Standard alignment with associated science practices and literature connections.
- From 2019 to 2022, the team worked to develop informal learning activities aligned with the GLOBE Observer protocols that engaged learners in authentic STEM experiences as a means of increasing learners' interest, self-efficacy, and awareness of the STEM career.[20]
- From 2022 to 2025, six additional NASA GLOBE informal learning guides were developed: Air Quality, Phenology and Pollinators, Remote Sensing, Soil, Urban Heat Islands, and Water Quality, expanding the learning resources to feature other GLOBE protocols beyond those on GLOBE Observer.



GLOBE Observer App

Camp Wa Ri Ki - WA

Informal GLOBE PD and Training

- During 2023 and 2024, three week-long NASA GLOBE Informal Learning PDs were conducted: Camp Discovery in Colombia, SC (Spring 2023); Shady Creek Outdoor Ed Center in Nevada City, CA (Spring 2024); and Wisconsin Lions Camp in Rosholt, WI (Fall 2024).
- Each of the PDs focused on two or three GLOBE protocols, with opportunity for camp educators to practice proper data collection procedures, collaborate with other camp professionals on their implementation plans, and discover learning activities to support their protocol development through real-world application.
- From 2019 to 2025, NASA GLOBE Goes to Camp training sessions were shared during the American Camp Association Conference (ACA).
- Additional PD sessions were shared during Regional ACA Conferences, the Tri-State Camp Conference in 2023, the Rocky Mountain EPIC Retreat in 2023, the National Rural STEM Learning Summit in 2024, and an Educator Workshop at the Hero Kids Foundation in 2024.
- From 2019 to 2025, summer camp virtual training sessions were offered for camp directors and their staff for each of the planned summer learning guides and protocols. Directors were able to select the protocols they would be implementing at their camp locations.
- In summers 2024 and 2025, a NASA Kick-off Virtual Event was held providing camp directors and their staff the opportunity to meet with NASA Subject Matter Experts prior to the start of the summer camp season.

Informal PD - Wisconsin Lions Camp 2024

STEM Summit 2024

Informal PD - Camp Discovery (SC) 2023

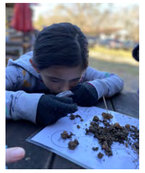
Informal PD - Shady Creek 2024

ACA 2023

Informal PD - Hero Kids Camp 2024

Photos Taken by the NASA GLOBE Camp Team

Accomplishments



- Impacting over 75K learners and their families, we have provided opportunities to connect with NASA Subject Matter Experts discussing the "NASA Why" for the importance of the data they were collecting as part of the NASA GLOBE Goes to Camp Project recognizing the local and global impact.
- From 2019 to 2025, we have provided over 45 NASA Subject Matter Expert virtual connections to camps, outdoor education centers, after-school programs, families, and schools.
- Based upon lessons learned from the summer camp pilot, the NASA GLOBE Camp-to-School Partnership Cohort was established in 2021 extending the projects reach to include learners throughout the school year in outdoor learning experiences.
- NASA GLOBE Goes to Camp hosted three in-person NASA GLOBE Informal Education Professional Development Opportunities (1-CA, 1-SC, 1-WI) to enhance the ability of camp educators to implement NASA GLOBE resources within their camp settings and interact with NASA Subject Matter Experts.
- As part of the NASA GLOBE Network of camps and outdoor education centers across the United States, the project has three volunteer NASA GLOBE Goes to Camp Mentor Directors that serve as a resources for camps representing the Eastern, Middle, and Western regions of the United States.
- As a component of the Camp-to-School Partnership Cohort, models of community-based STEM Learning Ecosystems are being established to bring elements of both formal and informal outdoor education together to work together to solve real-world environmental issues facing local communities. These range from week-long camp experiences to year long field investigations designed to allow learners to participate in authentic NASA citizen science as a means of increasing their STEM identities.

Parent and Educator Quotes

- "I have seen my child be more inquisitive and more confident in asking questions. I see the value in him learning to research and work as a part of a team. This is preparing him for middle school, high school, and beyond."
- "I have seen my child's interest in science and STEM increase drastically since he participated in this program, and he is very interested in being a Hydrologist and working at NASA one day."
- "I see great value in my child working on a collaborative research team, as it mirrors NASA's approach to problem-solving. This hands-on, inquiry-based model teaches her how to think critically, analyze data, and apply the science process in a meaningful way."
- "Makhi was quick to point out observations especially whenever we were outdoors. He would recall something he saw or that happened at NASA."

Lessons Learned

- In the initial planning phase of the NASA GLOBE Goes to Camp Project the intent was to implement GLOBE with summer camps; however, throughout the impact study it became apparent that there was a very specialized margin of summer camps for which the project was applicable.
- Summer camps that were the best fit for the NASA GLOBE Goes to Camp Project were those with a specialized purpose of incorporating STEM as a component or focus for the summer camp experience.
- Building upon this idea, we found that summer camps conducting programming with local schools throughout the school year became the lead camps throughout the project. Most of these type settings were outdoor education centers that hosted summer camps as well as engaging with learners through out-of-school time learning during the school year.
- The use of technology within summer camp settings vs outdoor education centers was also very different. Summer camps are often technology free zones, while outdoor education centers allow technology as a means toward a specific end such as for the purpose of data collection. In our work with summer camps, we tailored data sheets to meet the specific data collection goals based upon their implementation plans alleviating the need for technology. In working with outdoor education centers, we found them more open to implementing the GLOBE data sheets as they currently exist, aligning their data collection with GLOBE protocols.
- Based on feedback collected from our educators, the learning guides and supporting resources enabled them to easily incorporate NASA citizen science (GLOBE) within their programs with staff of varying STEM backgrounds, including those without formal training in STEM.

Next Steps

- Secure funding to continue NASA GLOBE Goes to Camp.
- Identify elements within the informal learning guides that would be more appealing to summer camps as an intro to NASA citizen science as a single learning activity, focusing the full-length guides for outdoor education centers.
- Expand connections with year-long out-of-school time opportunities that allow for the development of the inquiry-based learning model.
- Continue to grow the STEM Learning Ecosystem aspect of the project to include a more NASA STEM Career focused element connecting with industry and community business leaders.
- Continue to build the network of outdoor learning centers by broadening our efforts within the professional organizations and conferences with whom they are associated.
- Continue to expand the informal GLOBE Community of Practice.

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Observing Learning in Progress
In Informal Science Environments:
A tool to recognize behaviors characteristic of visitor learning

Through my exhibition evaluations, I have developed a system to look at documenting "learning in progress" via a set of *learning characteristics* and *influences on learning.* This has proven to be a useful tool for recognizing and identifying behaviors characteristic of, and associated with, the process of learning at science museum exhibits.

Learning Characteristics:
Utilizing…
- Executive Functioning Skills
- Communication Skills
- Observational Skills
- Critical Thinking Skills

Influences on Learning
- Affective Aspects
- Socio-cultural Aspects
- Operational and Mechanical

The first four behavior categories are directly associated with cognitive aspects of the learning process as cited in the Learning Literature.

A fifth category includes recognizable situations, which *influence* the learning process.

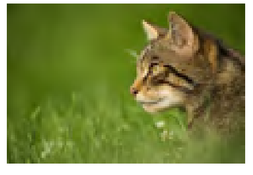
These five categories provide a useful framework for data collection and analysis.

Learning Characteristic Example:

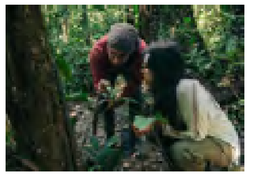
UTILIZING EXECUTIVE FUNCTIONING SKILLS (EFS)

EFS: Attraction and initial interaction to the exhibit

EFS: Focusing, concentrating + paying attention to the exhibit



EFS: Joint attention-attraction and focusing on the exhibit



Learning Characteristic Example:

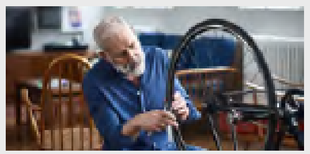
UTILIZING CRITICAL THINKING SKILLS (CTS)

CTS: Repeating, Comparing, Testing

CTS: Grasping Concepts

INFLUENCES ON LEARNING

Affective aspects of visitor experience at the exhibit. Socio-emotional behaviors.



Mechanical and operational aspects of the exhibit.

Socio-cultural aspects of visitor experience at the exhibit.

Bailey, E. (2023). In Search of an Articulated and Coherent Theoretical Framework to Inform Research and Evaluation of Learning in Science Centers: A Tale of Two Research Challenges. In: Patrick, P.G. (eds) How People Learn in Informal Science Environments. Springer, Cham. https://doi.org/10.1007/978-3-031-13291-9_25

Reimagining Informal STEM Education as Relational Becoming with People, Places, Pursuits

Priyanka Parekh (Northern Arizona University),
Ari Wilder (Flagstaff Unified School District, Camp Colton)

Rural learners recognize human and ecological affirmations of one's belonging in STEM.

Recasting the ecosystem as co-teachers and co-learners.

Relational becoming honors
The pursuits learners care about—tending animals, restoring streams, observing seasonal change—as legitimate forms of scientific engagement,
Values non-dominant epistemologies, including local and traditional.

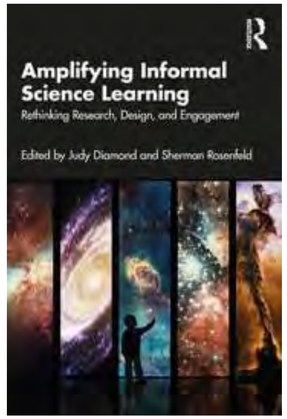
Relational becoming
The dynamic process through which individuals form identities and ways of knowing by engaging in reciprocal relationships with people, places, practices, and the ecosystem.

Draws attention to 'other' Discourses of STEM practice highlighting how recognizing relationality supports becoming with local ecosystems;
Recognizes non-dominant STEM practices and identities supports rural and remote learners' seeing themselves as 'STEM persons.

Let's ask:
What does it take to design informal STEM environments that center *relational becoming*?
How do we appreciate *becoming with* as a lens into learning and identity?

Science Museum Professionals' Reflect on Their Years Working in the Field

Dennis Schatz (schatz@pacsci.org)



Chapter with full analysis is in the above publication https://tinyurl.com/54eayshc

In 2022, I **sent a survey to 61 people in the science center field** (both international in the US). They **represented a wide range of perspectives** and included relatively new people to field, old timers, small and large institutions. There were **three simple questions**: 1) What are the top three to five things science museums have done well over the past three to five years? 2) What are the top three to five things science museums have done poorly over the past three to five years? 3) What are the top three to five implications for the future of science museums? **Forty-two people responded.** Below is a summary of the results.

Successes

1. The field developed a participant-centered and interactive engagement strategy that is the industry standard and influenced non-science-based museums.
2. Formative evaluation and front-end evaluation of exhibits and programs are now pervasive in the industry.
3. Taking exhibit and programs "on the road" to distant locations and non-science-based gatherings is offered by many science museums.
4. The participant-centered and interactive approach to science learning by science museums changed the way science is taught in schools.
5. The growth in the number of science museums is outstanding, making it easier for many smaller communities to have science museum experiences.
6. The field is generous in sharing resources, program/exhibit ideas, and lessons learned.

Implications for the Future

1. One of the highest priorities is to serve a more diverse audience, which requires the field to be more culturally responsive and inclusive. This will require more co-development of programs and exhibits where the audience is engaged throughout the development process and has an authentic influence on what is developed.
2. Closely related is the need for science museum staff and board to represent the diversity of the community that each science museum serves.
3. Science museums need to broaden the audience served by offering more programs for adults.
4. More programs/exhibits need to address important societal issues.
5. A new financial model for how science museums operate is essential to identify, which will be especially important if they want to serve a more diverse audience and focus on important societal issues.
6. Identifying a new financial model will require making the case for the positive impact science museums have on individuals and the community. This will require not only impact data, but "good stories" to share, and a long term development of effective relationships with and among decision makers (government and other funders).
7. It will be imperative for science museums to work with other organizations in their community to develop a broad, community-wide STEM learning ecosystem.

Seeing Scientifically 2.0

Developing accessible tools to support authentic scientific observation

an NSF Innovations in Development project @ The Exploratorium

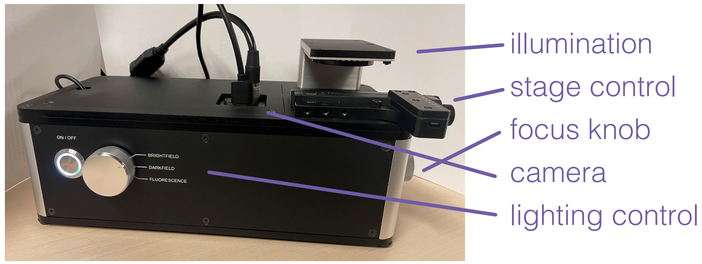
Key Takeaways

1. Systems should easily adapt to the needs of different venues and audiences
2. Reducing technological barriers helps adoption (ie no coding required)

Project Goals

1. Develop and evaluate strategies to scaffold informal learners in the practice of authentic scientific observation of biological phenomena.
2. Make exhibit easily adaptable to diverse biological specimens and accessible to smaller informal science education venues.

Low-cost microscopy



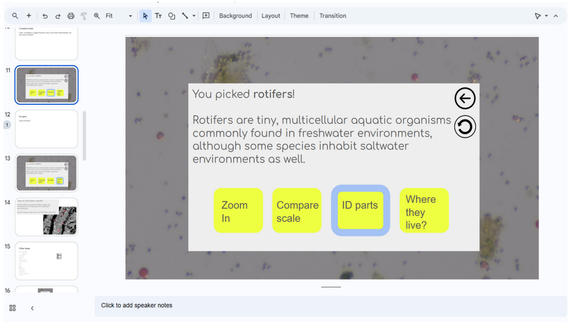
The Fletcher Lab at UC Berkeley has developed a low-cost, portable, high-resolution microscope with an embedded camera.

WOMBAT: Story-writing platform

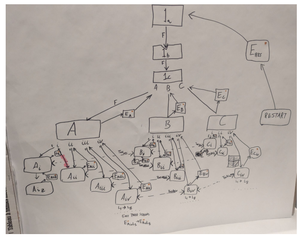
We developed a user-friendly GUI named WOMBAT to write an interactive story with embedded tools, such as AI object detection and microscope controls (shown on the left). These features can be used to help scaffold the informal learning experience.

Storyboard development use case: BioBus in NYC

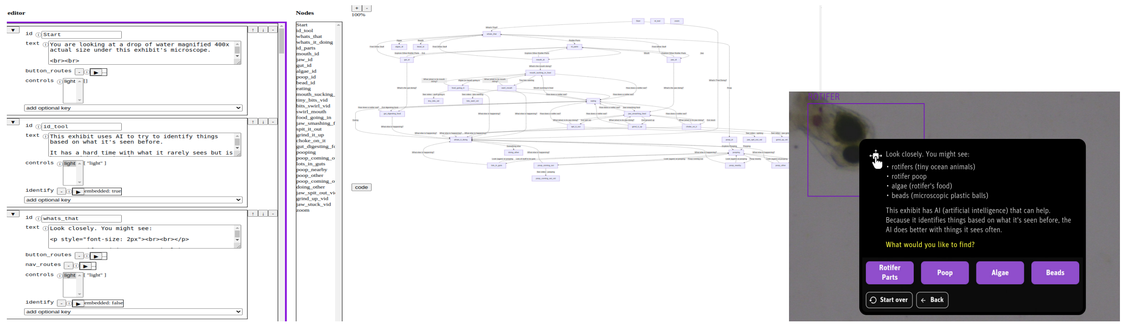
Without WOMBAT: Pen and paper, slides, outsourced programming




```
rotifer_id:
  text: |
    Rotifers are microscopic animals that live in the water. They  eat almost constantly
    They are translucent so you can see their insides.
    <br><br><span style="color:yellow">Use the tool to identify its body parts.</span>
  nav_routes:
  - text: So What?
    route: backfromrotid
    icon: back
  lens_routes:
  - text: Id Parts
    route: rotifer_id_lens
    icon: lens
```



With WOMBAT: Point-and-click, no programming, in-house



Poster prepared and presented by Amanda Meriwether and Sylvia de la Piedra.

This material is based upon work supported by the National Science Foundation under Award No. 2005893.

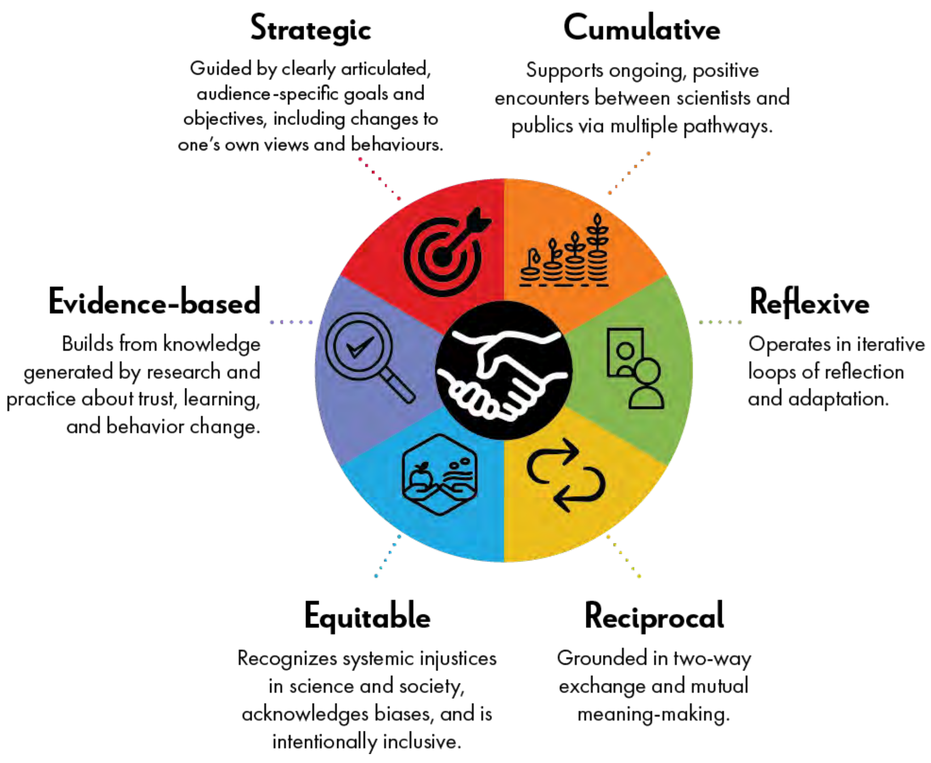
Strategic Science Communication: From Research to Practice

Advancing Public Engagement Across LTERs

APEAL

For Practice Briefs in English and Spanish

The SCRREE Framework includes six principles that can help ensure successful, ethical public engagement (PE) efforts. It is based on research, experience, and need (Garlick et al., in review).



Here's some of what we've learned about applying SCRREE to practice:

Asking scientists to begin thinking about PE as **cumulative** can help overcome the tendency to plan one-off events.

Scientists are more likely to do PE if they think it will be beneficial (Besley & Downs, 2024); focusing on mutual benefits helps ensure PES activities are **reciprocal.**

The use of **reflexive** practice to design PE is becoming more commonplace. It improves transparency and helps build trust (Lopez & Feliu Mojer, 2025).

THE KAVLI FOUNDATION

NSF

This material is based upon work supported by the National Science Foundation (NSF, Grant AISL 2215188, 1421214-1421723. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF.

- SCRREE graphic, courtesy of Jessica Sawyer jessica.sawyer@oregonstate.edu
- Besley, J. C., & Downs, M. R. (2024). Ecologists prioritize listening to community perspectives when they see the benefit: Norms and self-efficacy beliefs appear to have little impact. *Science Communication*, *46*(4), 511-537.
- Garlick, S., Besley, J; Peterman, K.; Black-Maier, Al.; Downs, M.; Ortiz Franco, E.; Groffman, P.; Lavallee, A.; O'Connell, K.; Storksdieck, M.; Templer, P. (in revision) Six elements of effective public engagement with science. Frontiers in Ecology & the Enironment.
- Lopez & Filiu Mojer (2025) Reflexivity Workbook, https://www.reflexivityworkbook.org/

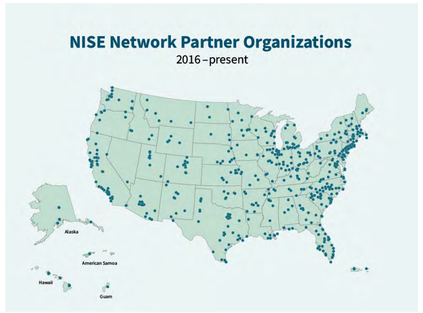
The Power of Networks to Increase Capacity of Informal Science Educators to Engage Local Communities:

An Example of the National Informal STEM Education Network (NISE Network)

The National Informal STEM Education Network (NISE Network) is a collaborative network of partner organizations and scientists who develop educational materials designed to engage the public on a variety of current science and technology topics in informal learning settings on a nationwide scale. The NISE Network generates, develops, implements, and collaborates on projects that strengthen and advance informal STEM learning in communities across the United States.

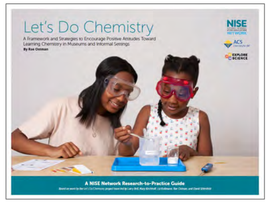
Collaborative Networks at a National Scale

NISE Network achieves our impact through our partner organizations, which include science centers, children's museums, natural history museums, universities, and many others. Network projects create educational materials, support professional learning, and build capacity through collaboration and networking. Network partners create and share resources, knowledge, practices, and ideas. As a professional community, we are committed to learning alongside each other and to evolving the way we work as a result.



Building Capacity with Professional Learning

NISE Network's theory of action focuses on creating and sharing resources that increase the capacity of informal science educators to effectively engage their own local communities. Resources designed to increase practitioner knowledge and skills include written guides on activities and practices, training videos, online workshops, professional learning communities, and in-person training.
nisenet.org/pd



Co-Creation with Experts and Local Communities

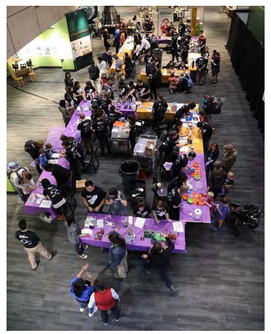
NISE Network educational materials are created through an iterative, collaborative process that involves scientists with expertise in the content area, informal science education professionals, and public audiences. Co-creating with experts and with communities helps to ensure that our public engagement materials are scientifically accurate, represent best practices in educational product development, and are safe, effective, and relevant experiences for learners of all ages.
nisenet.org/working-with-experts
nisenet.org/cocreatingcommunities

Embedding Ethical and Societal Implications

Programs are designed to incorporate ethical and society implications instead of simply focusing on "just facts." These themes are baked throughout a program, rather than just sprinkled on top.
nisenet.org/society
nisenet.org/catalog/nanotechnology-and-society-guide

Large Scale Distribution Models

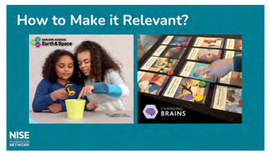
NISE Network has effectively implemented large-scale distribution of kits, exhibits, and mini-grants to partners nationwide on different STEM topics. **Kits** containing hands-on activities, consumable supplies, event planning materials, partnership guides, and professional learning resources were distributed to hundreds of museums nationwide. Small footprint **exhibitions** have been distributed to museums who take ownership and often share exhibits among regional networks. **Mini-grant** funding has enabled partners to customize local engagement to meet the needs and interests of their communities. These large-scale initiatives create the ability for educators and scientists to participate in nationwide programing, and in turn, learn and become inspired by each other.
nisenet.org/small-footprint-exhibition-big-impact
nisenet.org/catalog/nanodays-guide



Photos courtesy of Museum of Science, Boston, MA, Discovery Station, Hagerstown, MD, and Science Museum of Minnesota, MN

Designing for scale: intentionally planning for adaptation to increase relevance

To successfully achieve equitable scaling, public engagement materials should be intentionally designed to be easily shared and adapted locally. Easy customization helps to ensure experiences are relevant to local communities and appropriate for use in different settings. NISE Network encourages customizing content for local communities rather than a "one size fits all" model emphasizing fidelity.
nisenet.org/making-stem-relevant
nisenet.org/development_process-more
ngcproject.org/ScalingInformalSTEMPrograms



Fostering Multi-Directional Conversations

Programs are designed to foster two-way conversations among members of the public with informal educators and scientists. This practice builds trust between the public and scientists, as well as mutual learning about science content and societal values.
nisenet.org/public-engagement-conversations-guide

Arizona State University

Catherine McCarthy, NISE Network Director,
Arizona State University cmccar16@asu.edu

NASEM Convocation on the
Status of Informal Science and Engineering Education
June 2025

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- National Science Foundation under award number DRL 2053160, DRL 1612482, DRL-1516684, DRL 1421179, 0532536, and 0940143.
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Who is Studying the Informal Science Educators?

Megan Ennes & Kieren Rende Mendoza
University of Florida, University of Nebraska at Omaha

1990s

NSTA releases statement on informal science education

Falk and Lynn D. Dierking introduce the *Contextual Model of Learning* proposing that museum learning is influenced by personal, social, and physical contexts.

2000s

Research Focus on educator pedagogies, roles, and professionalization/professional development.

Notable Authors:

Bailey, Bevan, Dillon, King, Rennie, Stocklmayer, Tran

2010s

Research focus on professional learning and reflecting on practice, assessing self efficacy and climate change communication. Several handbooks are released.

Notable Authors:

Afonso & Afonso, Ash, Ennes, Fraser, Holliday ,Lederman, Patrick, Swim, and Tran

2020s

Research focus on equity and inclusion, culturally relevant teaching impacts of COVID-19, wellbeing, belonging, identity, and more professionalization/ self-reflection.

Notable Authors:

Ben-Zvi Assaraf, Busch, Ennes, Gupta, Heimlich, Kumudu, , Morrissey, Rende Mendoza, Schatz, and Tran

1. We have spent many years discussing the professionalization of the museum education field. What progress have we made? Is this still a need?
2. There is more of a focus on the individual educators. What does this mean for the field?
3. There has been a lot of work related to equity, inclusion, and culturally relevant teaching. What does that look like in this current climate?
4. What areas should we focus on related the educators facilitating in informal science spaces moving forward?

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