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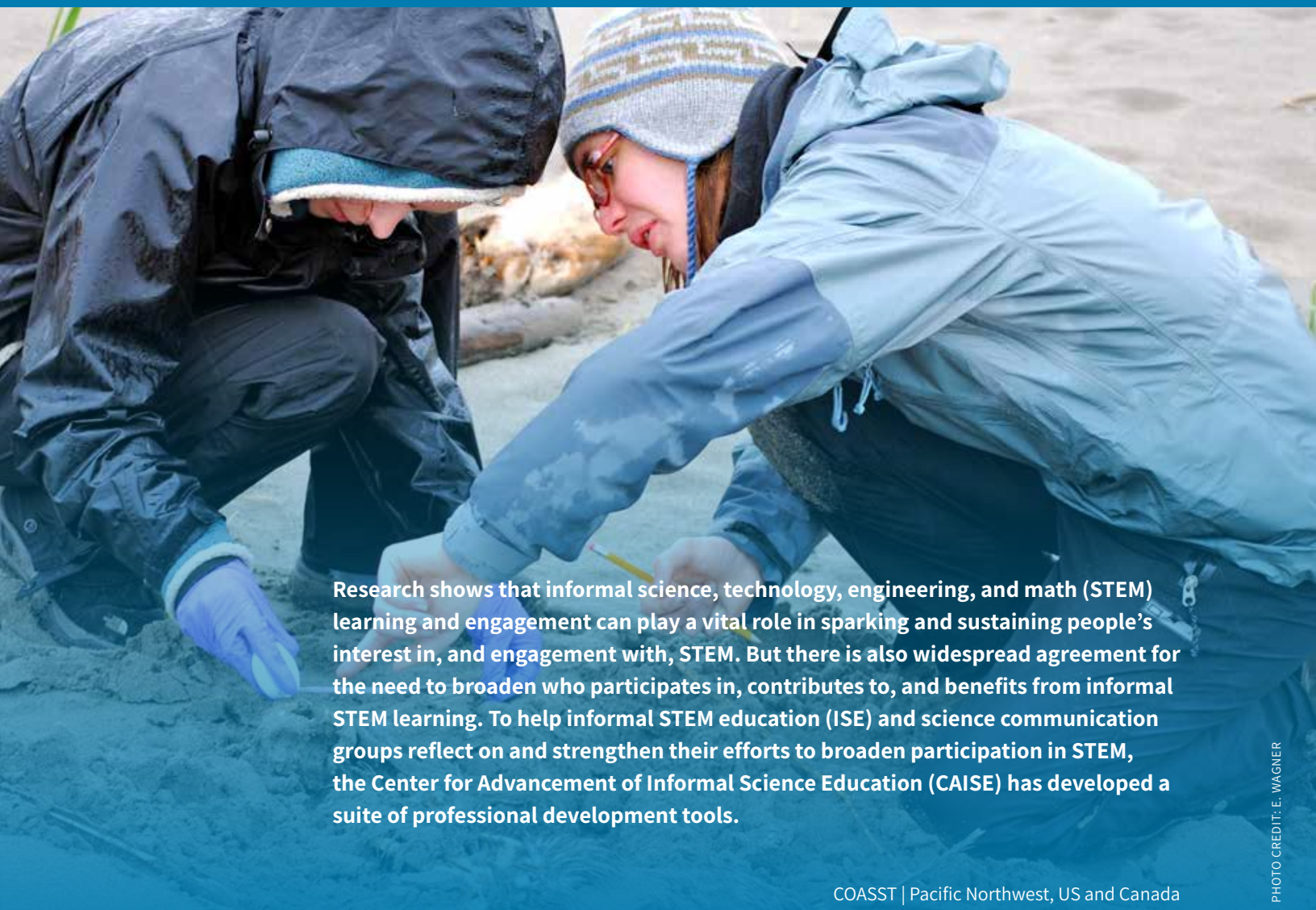
Broadening Perspectives on Broadening Participation in STEM

Toolkit Overview



Research shows that informal science, technology, engineering, and math (STEM) learning and engagement can play a vital role in sparking and sustaining people's interest in, and engagement with, STEM. But there is also widespread agreement for the need to broaden who participates in, contributes to, and benefits from informal STEM learning. To help informal STEM education (ISE) and science communication groups reflect on and strengthen their efforts to broaden participation in STEM, the Center for Advancement of Informal Science Education (CAISE) has developed a suite of professional development tools.

COASST | Pacific Northwest, US and Canada

PHOTO CREDIT: E. WAGNER

Is this for me?

If you are a staff leader or trainer who is thinking about ways to strengthen your organization's or professional audience's efforts in broadening participation, these resources can help support your work. You can use them to plan and lead reflective discussions about current practices, with an eye on developing goals, strategies, and priorities that can make ISE and science communication work more inclusive.

What can I find here?

In this toolkit, you'll find resources that can support you and your organization's efforts in broadening STEM participation. The resources include:

1. **A report, *Broadening Perspectives on Broadening Participation in STEM***, that identifies four key foundational issues that are essential to consider for any effort to broaden participation in STEM to be successful. This synthesis draws from both research and practice. It is intended **for you**, the person leading group discussions, to read in advance of talking with your colleagues or professional audiences.

2. **A two-page summary for stakeholders**, like a supervisor or board chair, that describes why engaging in this work is valuable for enhancing the relevance and impact of your organization in its community. It is intended **for them**, in order to gain support for your efforts.

3. **A set of practice briefs**, each focusing on a specific topic relevant to broadening participation in STEM, that includes ideas to consider and recommendations for action. Briefs also include examples of promising public engagement programs, further reading, and links to more tools and resources. They are intended **for your staff**, colleagues, or professional audiences/trainees to read in advance of having reflective conversations about professional practices. Briefs include:

   I. Why Broaden Perspectives on Broadening Participation in STEM?

   II. What Does Learning Have to Do With Science Communication?

   III. What Does Asset-Based STEM Learning Look Like?

   IV. What Are the Cultural Norms of STEM and Why Do They Matter?

   V. What Is Considered "STEM" and Why?

   VI. How Can We Help Scientists Adopt Equity Approaches to Science Communication?

   VII. What Is a STEM Learning Ecosystem?

   VIII. How Can We Re-Think Assumptions About Parent Engagement?

   IX. How Can We Build on Existing Assets Within a Community?

   X. How Can Institutions Model Inclusion in the Workplace?

   XI. What Does Working "With" (not "For") Our Communities Look Like?

4. **A conversation guide**, with tips and a summary of the big picture issues. It is intended for you, to help you facilitate discussions about ideas found in the report and briefs.

All items listed above can be accessed here: informalscience.org/broadening-perspectives

How do I use what's here?

1. **Start by reading the *Broadening Perspectives* report** to jumpstart your thinking and inform the conversations you might want to have with your staff, colleagues, or professionals in your training programs.
2. **Get stakeholders on board** by sharing the summary with them.
3. **Organize a series of group conversations** to explore some ideas and ways to strengthen broadening participation understanding and efforts. Our recommendation is to organize a series of at least five discussions, each using one or two briefs that participants are asked to read in advance.

The briefs are introductory in nature, meant to be used with professionals who may be grappling with, or are enthusiastic about, how broadening participation may require them to rethink their normal practices. They are intended to do the following:

- Build on current research to define the challenge of broadening participation for an organization or program.
- Re-envision what equity in public engagement with STEM looks like and the role of organizations and individuals in advancing it.
- Identify potential areas for growth and development within teams, organizations, or practices.

4. **Use the conversation guide** to help facilitate each group conversation.

PHOTO CREDIT: RESEARCH + PRACTICE COLLABORATORY

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Broadening Perspectives on Broadening Participation in STEM

By Bronwyn Bevan, Angela Calabrese Barton, and Cecilia Garibay

About the Authors

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This report summarizes the ideas and conversations of the CAISE Broadening Participation Task Force, which was led by the authors, along with James Bell, Principal Investigator and project director of CAISE (see informalscience.org/bp-task-force). The task force was instrumental in identifying key ideas and challenges to the field, providing edits and input into the report, developing and drafting the associated practice briefs, and piloting the materials.

About CAISE

The Center for Advancement of Informal Science Education works in cooperation with the National Science Foundation's Advancing Informal STEM Learning Program to build and advance the informal science, technology, engineering, and math education field by providing infrastructure, resources, and connectivity for educators, researchers, evaluators, and other interested stakeholders working in media (TV, radio, film, and social), science centers and museums, zoos and aquariums, parks, botanical gardens and nature centers, events and festivals, libraries, making and tinkering spaces, cyberlearning and gaming, and youth and out-of-school-time programs.

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Introduction

Why this report?

- **Across the nation, many are undertaking efforts to significantly transform who participates in science, technology, engineering, and math (STEM), but the informal science education and science communication sectors are largely peripheral to these efforts.**
- **Rather than assume that this exclusion is an oversight, we examine how our fields typically present and represent STEM, and if and how we do so in truly inclusive ways that can contribute to efforts to broaden participation.**
- **Organizations, programs, and people within our fields can reflect on and question our work to determine if and how it can be made more equitable and inclusive.**

There is widespread agreement about the urgent need to broaden the diversity of people who participate in, contribute to, and benefit from science, technology, engineering, and math—the disciplines collectively known as STEM. For too long, non-dominant populations in the US have been significantly underrepresented in STEM academics, professions, and civic decision-making. The situation indicates a system-level failure to recognize, nurture, and channel all young people's early interests in STEM into longer-term pursuits or to adopt inclusive approaches for adults participating in STEM events or learning experiences.

In response, the National Science Foundation (NSF) and many professional communities across the country are developing comprehensive approaches to measurably broaden who participates in STEM (NSF, 2018). These efforts largely center on K–12 and postsecondary science education. The many other diverse types of lifelong STEM learning and engagement, for both youth and adults, currently play mostly a peripheral role within these efforts.

Decades of research demonstrate that engaging with STEM outside of school can play a critical role in sparking and sustaining people's interest in, readiness for, and commitment to academic, professional, and lifelong engagement with STEM (National Research Council,

Non-Dominant Populations

In this report, we use the term "non-dominant populations" to include ethnic minority, female, immigrant, and other social groups who historically have not held positions of power in US political and corporate enterprises.

Some use this term because it points to differences in power and not simply representation (for example, women make up a greater proportion of the population but do not dominate government, civic, or institutional positions of power). Others do not use the term because it suggests that power is fixed rather than fluid and dependent on context.

Other terms—such as underserved, underrepresented, minority, and others—have also been used to describe populations that are typically underrepresented in positions of power and privilege, or in STEM-based fields.

2009, 2015). STEM programs and initiatives outside of school include science festivals and events, STEM-related hobby clubs, afterschool and summer STEM programs, citizen science and community science programs, science centers, museums, zoos and aquariums, and nature centers, as well as science content in television and radio broadcasts, social media, print journalism, and other media. Indeed, research finds that these STEM experiences can be critical catalysts for lifelong commitments to STEM engagement (COSMOS Corporation, 1998). As comprehensive, systemic efforts to broaden participation get underway in communities across the country, what role can the fields known as science communication and informal STEM education play to ensure success?

A task force to take stock and reflect

Starting in 2017, a 15-member task force assembled by the Center for Advancement of Informal Science Education (CAISE) set out to identify challenges and opportunities related to our work in broadening participation (see page 19 for more information and a list of members).

The task force did not begin its work with the assumption that informal STEM education and science communication were significantly contributing to broader participation. Nor did we assume that these fields' lack of centrality in systemic efforts was due to an oversight on the part of the architects of those efforts. Instead, we chose to focus on how the current approaches of our sector might, in fact, be limited in their impact. We looked to promising public engagement with STEM programs and examples, as well as to research and theory on how people learn, to reflect on and understand how we might strengthen work in the field in order to become more centrally positioned in comprehensive strategies for broadening participation in STEM.

What you will find in this report

In the following sections, we share what research and practice have to say about why, how, when, and where we can take a more active and critical stance in our efforts to broaden participation. This document is meant for science communication or ISE professionals who plan to lead reflective professional conversations about equity and inclusion. It has a level of detail meant to support your efforts, but may be too detailed and lengthy for your colleagues or trainees, for whom we have developed an associated set of short readings we call practice briefs. Each section includes recommendations for which briefs you might share with your colleagues or trainees, and ends with a set of questions you can use to engage them in reflecting on the issues raised in the section and briefs. The final section of this report, *Taking Action in Your Own Organization*, walks you through how to use the full toolkit developed by the task force.

Related Practice Briefs

A set of companion briefs provides a closer look at specific topics. Within the report, we have flagged places where a brief might deepen understanding.

Public Engagement with STEM

In this report, we use the term "public engagement with STEM" to include multiple yet related and sometimes overlapping sectors, initiatives, and activities within the fields of informal STEM education (ISE), out-of-school-time STEM learning, and science communication. This definition allows us to broadly reference learning and engagement that happens outside of K–12 schools and higher education; across ages, among children, youth, and adults; and in different social settings, including individual, group, or family environments.

What Is the Issue?

The Need for a Critical Conversation

- **Many communities are significantly underrepresented in STEM academics, careers, and civic decision-making.**
- **ISE and science communication have been shown to be critical for advancing lifelong engagement with STEM, but these experiences are not taken up equally across our communities.**
- **Traditional approaches to "broadening participation" in STEM do not take a critical (e.g. a historical, political, or socio-cultural) view of the situation, which may be why such approaches appear to have limited impact.**
- **We need to re-think and re-frame how we approach broadening participation to make it more equity-oriented.**
- **Further, we argue for a need to take a critical stance—to question assumptions and examine the evidence—when discussing our field's work on broadening participation.**

"Broadening participation in STEM" has generally referred to increasing participation (attendance, enrollment, involvement) in STEM studies, professions, and civic decision-making of people from communities historically underrepresented in STEM. These communities include people of color, people with disabilities, women and girls, people living in poverty, people who were formerly incarcerated, and others. In this view, the challenge and the solution focus primarily on creating access to existing pathways into STEM and increasing the number of those pathways. The assumption underlying this approach is that when points of access are increased, more diverse and more representative populations will have more opportunities to participate in STEM and that they will pursue those opportunities.

Although access and opportunity are fundamentally important considerations in broadening participation, research suggests that the challenge is more complex. Increasing opportunities of the kind that were designed for and have proven effective for dominant culture populations—for example, replicating these opportunities, making them low or no cost, or issuing more targeted invitations—does not suffice (Dawson, 2014; Feinstein & Meshoulam, 2014).

STEM Pathways

By "pathways" we mean the (sometimes meandering) sequences of STEM experiences and opportunities that people pursue across a range of informal and formal settings; some of these may lead to advanced academic and career choices. Pathways are offered as an alternative to "pipeline models" which have been critiqued as oversimplified (Cannady, Greenwald, & Harris, 2014).

Moreover, an "access-alone" approach places the burden of participation on non-dominant populations. It suggests that lack of participation is not due to the nature of STEM engagement programs that are available or to a history of systemic exclusion, but rather to individuals' lack of awareness, transportation, funds, etc. It does not question whether engagement programs and opportunities may be designed, intentionally or not, to reproduce existing patterns of STEM participation. Fundamentally, an access-alone approach represents an uncritical perspective on the question of which people participate in STEM and why.

The role of public engagement with STEM in broadening participation

Researchers have found that the average American spends 95 percent of their lifetime outside of school (Falk & Dierking, 2010). Even school-aged young people spend only 20 percent of their waking hours in school when one accounts for weekends, school holidays, and the hours before and after school (Banks et al., 2007). During these non-school hours, people engage with STEM in many ways—on television, via social media and mainstream news, in afterschool clubs, libraries, museums, and zoos, in sports, and in their backyards and homes. In these settings, people come to see STEM as something that either is or is not useful, valued, and relevant to their lives. These perceptions naturally influence whether and how they pursue more structured opportunities to engage with STEM. National Research Council (NRC) syntheses of decades of research have found that informal learning environments can be especially effective at engaging non-dominant communities in STEM, when programs are designed to be intellectually and emotionally engaging, culturally responsive, and connected to other learning experiences (NRC, 2009, 2015).

But children and youth do not access out-of-school enrichment equally. The richest fifth of US families spends over seven times more on their children's out-of-school time than the poorest fifth (Duncan & Murname, 2011). And studies find that many public engagement with STEM programs, including museums, science festivals, hobby clubs, and citizen science projects, primarily serve middle-class and white audiences (Dawson, 2017; Feinstein & Meshoulam, 2014; Pandya, 2012).

More inclusive and culturally responsive informal STEM learning programs, such as those described in a 2015 NRC report, are often powerful but limited in the number of participants they reach. These programs can be effective in initiating and deepening STEM engagement, but there is often limited follow-through to ensure that people who want to continue with STEM can do so. The effects of failing to broker future science engagement opportunities falls most heavily on communities contending with under-resourced schools, fewer STEM professional role models, and cultural messages that have historically discouraged participation in STEM.

Leading Reflective Conversations

As you think about and engage your colleagues or trainees in the issues raised in this section, you might want to consider the following overarching questions:

- In what ways have our programs/organizations tried to broaden participation in STEM and how impactful have these efforts been and why?
- In what ways is broadening participation in STEM a part of our organizational mission?
- If we could really "move the needle" in broadening participation in STEM, how would that make our programs or organization stronger, more impactful, and/or more valued by our varied stakeholders?

Efforts that exemplify inclusive public engagement with STEM

The public engagement with STEM sector has pioneered many effective strategies for equity and inclusion, and has developed theory and practice that can guide future work. Here are a few brief examples:

1. Programs like the science track at **DragonCon** (science.dragoncon.org) engage superhero fans with the science behind the special powers, special materials, and special worlds.

2. **Ciencia Puerto Rico** (CienciaPR; cienciapr.org) enlists scientists to engage the public on issues central to the island's devastated infrastructure.

3. In the **Youth Rock STEM club**, researchers have worked with youth at a refugee-residential community center in North Carolina (Tan & Faircloth, 2016).

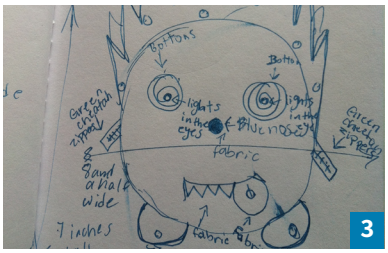
4. The **INSPIRE** project in Utah (nalininadkarni.com/about/science-for-the-incarcerated) is bringing STEM to the incarcerated through lectures, workshops, and conservation projects.

5. Responsive co-design with indigenous communities is being modeled in **Native Universe** (nativeuniverse.org), a project focused on systemic change in museums, and in **TechTales**, where families are encouraged to bring their expertise and cultural knowledge to engineering workshops (stemforall2018.videohall.com/presentations/1144).

6. Gender equity programs such as **Science STARS** (getrealscience.org) and **Techbridge Girls** (techbridgegirls.org) have influenced girls and young women to pursue STEM studies and careers.

7. Youth programs like the **Detroit Area Pre-College Engineering Program** (DAPCEP; dapcep.org) and **Green Energy Technology in the City** (GET City; getcity.org) have demonstrated success with youth from non-dominant populations.

These efforts share a commitment to designing public engagement with STEM programs with and for their target audiences. Starting with participants' interests, the programs have developed experiences that build participants' ability to use science as a tool for personal or community development. These are powerful demonstrations that public engagement with STEM has the potential to change who participates in, contributes to, and benefits from STEM.



STEM to What Ends?

Pipelines, Pathways, and Agency

- **Efforts to broaden participation often adopt narrow views—towards careers, via a "pipeline model"—that do not take into account the broad, meandering, and diverse ways in which people may choose to participate in STEM engagement opportunities.**
- **Access to high quality STEM engagement experiences and opportunities are not equitably distributed in the US. There is a need to expand the quality and quantity of STEM engagement opportunities.**
- **Choosing to take up opportunities depends not only on access but on the perceived value of those opportunities for one's history, community, hopes, and desires. Adopting asset-based approaches can help people to see how STEM can be useful and meaningful to their lives, including why they might choose to pursue it academically.**

Broadening participation is sometimes framed as changing the number and nature of participants in lifelong, academic, and career STEM pursuits. Access to opportunities to engage with STEM is a crucial issue of equity. The fastest-growing US career sectors are STEM-based. Further, some of the most pressing societal issues of our time, including climate change, artificial intelligence, gene editing, food production, and water quality, have STEM at their center (Ito et al., 2012). But access to opportunities is not the only issue of equity.

Efforts to diversify the STEM workforce often use the "STEM pipeline" metaphor to describe the need to get more diverse populations on a journey towards STEM careers. These approaches concern themselves with increasing the number and diversity of people who go into the "pipeline" at the entry point, typically considered to be before middle school, and then with "plugging leaks" throughout K–12, postsecondary, and graduate school, with the end goal that participants stay in the STEM pipeline (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007). This approach has been critiqued for not acknowledging that people find different ways into STEM careers and that STEM understanding and education can be applied in many ways beyond careers (Cannady, Greenwald, & Harris, 2014; Vossoughi, Hooper, & Escudé, 2016).

What Does Learning Have to Do with Science Communication?

Many science communicators are uncertain or wary of applying the term "learning" to their work. This brief discusses why and how adopting broader views of learning, as more than conceptual recall, can enrich our definitions of learning and our practices of science communication.

In contrast, the "STEM pathways" metaphor has been used to describe a system with many entry points and trajectories for STEM engagement. The concept of "pathways" sees people coming to STEM at various ages and stages and engaging in varied and unique ways. In fact, a study of the National Education Longitudinal Study of 1988 (Cannady, Greenwald, & Harris, 2014) found that a significant number of life sciences majors did not choose science until they were in college. A pathways approach is relevant to workforce development, civic engagement, and science literacy. It emphasizes the need to create multiple entry points into STEM and to ensure that opportunities are connected in ways that allow expanding engagement with STEM.

Both metaphors address key challenges for public engagement with STEM. But both, for the most part, rely on programs that adopt standard academic and professional models of what STEM professionals and practices look like—the same models that are historically associated with the exclusion of non-dominant communities from STEM. This can tend to orient programs around conceptual knowledge alone, with less time spent on the social and cultural practices and uses of science that may speak to people who have not already "opted in" to science.

Building on outcomes evidence from a number of productive public engagement with STEM programs (Calabrese Barton & Tan, 2010; Calabrese Barton et al., 2013; Haklay, 2013; Theobald et al., 2015), we propose an additional way to think about broadening participation by conceptualizing participation as a means for personal and community agency.

This model recognizes the many ways that STEM is valuable to individuals and communities not only in career choices but also in everyday life (National Academies of Sciences, Engineering, and Medicine, 2016). Examples of programs that use an agency model include:

COASST (or the Coastal Observation and Seabird Survey Team) is a community science program in an Alaskan Aleut community in which adult participants gather scientific data to monitor fishing conditions (depts.washington.edu/coasst) ▼

In the Utah-based STEM Ambassador Program, a scientist discusses bird identification and his ornithology research with outdoor recreation guides (www.stemap.org). ▼

In Youth Rocks STEM, a program in North Carolina, refugee youth develop skills in e-textiles to create light-up stuffed toys for younger siblings. ▼

These programs present STEM in a significantly different way than traditional pipeline or pathways models. Rather than learning or pursuing STEM as the purpose of the programs, STEM is positioned as the means for personal or community transformation. The programs are successful at broadening STEM participation because they do not rely on models that try to draw people to STEM but rather integrate STEM into "where people are" in their daily concerns, interests, and activities.

Leading Reflective Conversations

As you think about and engage your colleagues or trainees in the issues raised in this section, you might want to start by articulating your vision of what "broadening participation" means. Is the goal to lead people towards academic pursuits (a pipeline model)? Towards civic, academic, and career engagement (a pathways model)? Towards personal and community agency? Your vision of the purpose of broadening participation—the why—will have direct implications for how, when, and where.

Questions to consider

- What kinds of STEM opportunities does your program or organization offer to your public audiences? What does "participation" look like?
- What kinds of expertise do you help participants to build? How are these forms of expertise connected to their everyday lives and their social futures?
- Who does not participate? What do you know of those people's interests and concerns? How does or how might your program or organization include these concerns?

What Does Asset-Based STEM Learning Look Like?

This brief provides a comparison of deficit-based versus asset-based approaches to engaging science communication audiences and other learners.

What Does Participation in STEM Look Like?

Challenging the Dominant Cultural Norms of STEM

- **The cultural norms of STEM in academia and the professions are specific to the communities that have built those enterprises; as such, they can be alienating and unwelcoming to others.**
- **Programs that seek to intertwine the cultural norms and practices of their audiences with those of STEM professionals can be seen as more welcoming, can bridge connections, and can deepen engagement.**

In addition to reconceptualizing why people choose to engage with STEM, it is important to consider how people are asked to engage with STEM. Pipeline and pathways approaches often translate to efforts to increase diversity among people who participate in STEM programs and experiences. They sometimes pay limited attention to how those programs and experiences may welcome the wide range of cultural assets that different groups bring to STEM.

Research finds that most audiences for public engagement with STEM in the US are white, college educated, and middle class. This lack of diversity is often distinctly visible. This, in and of itself, may keep people in other communities from feeling fully welcome or comfortable. Beyond the lack of diversity of participants, frequently the means of participating—the ways of speaking, working, and acting—are also not diverse. Indeed, the dominant cultural norms for engaging in STEM typically are the norms of the populations that have participated in and institutionalized STEM as we know it today.

What Is Considered "STEM" and Why?

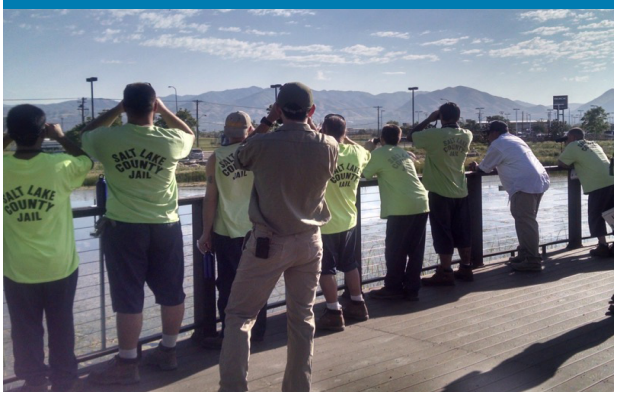
This brief notes the many ways that STEM concepts, phenomena, and practices are encountered or deployed in everyday settings. It suggests that taking a broader view of "what counts" as STEM can be a powerful way for broadening participation in STEM.

For example, in the US, successful (rewarded) engagement in STEM activities is often characterized by:

- Individual achievement: the "lone genius"
- Verbal argumentation
- Challenges to authority
- A strict division between the animate and inanimate
- A mind-body duality, including a separation between reason and emotion.

What Are the Cultural Norms of STEM?

This brief further explores concrete ways cultural norms might impact non-dominant populations in relation to STEM learning.



Some of these cultural norms are highly valued in STEM fields. However, they may be seen as rude, inappropriate, or conceptually misguided in non-dominant communities, which may instead emphasize collective decision-making, deference to elders, joint meaning-making, and other more cooperative norms. If individuals feel that participating in STEM requires them to leave their cultural norms behind—to change themselves, to reject the norms of their families and home communities—they may choose instead to reject STEM disciplines. Furthermore, when programs and organizations do not intentionally design engagements to integrate the cultural norms of non-dominant communities, designers easily default to deficit-based approaches—seeing difference as a deficiency or a problem rather than a resource.

Broadening participation will require redesigning public engagement programs to legitimately value people and their cultural experiences. Along these lines, there is much to learn from the literature that explores the cultural dimensions of learning and engagement in STEM. For example, Medin and Bang (2014) have described how they designed environmental science programs to privilege Native American and Western science equally. These programs acknowledged indigenous ways of conceptualizing natural forms, such as rivers or skies, as living entities. They then used Western science to explore the dynamics of these complex systems, for example, to understand rivers in relationship to the flora and fauna that both shaped and were shaped by the river systems. This approach built on indigenous cultural knowledge systems and norms by engaging young people along with their family members and by interweaving traditional lore about the local river with scientific inquiries into the ecosystem (Bang & Medin, 2014).

Thinking about the broad range of ways STEM influences daily life makes it easier to build on a community's strengths and its ways of using and valuing STEM in day-to-day social life. For example, as described by Birmingham and Calabrese Barton (2014), a group of middle school youth were worried about their families saving money during a major economic recession. They asked their afterschool STEM teachers if they could use what they had been learning about energy and the environment to host a green energy carnival to share useful ideas and resources with their families. They spent four months pulling together what they had learned about energy efficiency to design activities and experiences for people of all ages. For example, they "hacked" an old bike so that pedaling it could recharge a phone.

They created an experiment to enable participants to see and feel the differences in the light and heat energy given off by different kinds of lights. They provided experiences with geographic information system (GIS) mapping technology to help participants to locate local free resources for energy efficiency. As one young person remarked, the project had allowed participants to become "community science experts...doing things that are good for the community because of what we know. We know a lot of science and we also know a lot about our community. Who else can put these ideas together?"

Leading Reflective Conversations

As you think about and engage your colleagues or trainees in the issues raised in this section, you might want to think about how your (or their) program or organization presents STEM or designs STEM engagement activities in ways that reinforce dominant cultural norms—and therefore may or may not be as welcoming and inclusive as you intend. Consider how to broaden these norms to include and build on the cultural norms of target participants.

Questions to consider

- What does successful participation in your program or organization look like? What kind of cultural norms—ways of speaking, sense-making, inquiry, activity, and interaction—are valued?
- Do participants have multiple and varied opportunities to use their everyday and cultural knowledge and practice in your activities? In what ways?
- Do you have guidelines for designing and evaluating your programs in ways that support cultural inclusivity?

How Can We Help Scientists Adopt Equity Approaches to Science Communication?

This brief is intended to help those who work with STEM professionals reflect on their personal goals and motivations prior to engaging in outreach and education activities.

How Does Participation Unfold Across Time and Space?

Adding Value to Local STEM Learning Ecosystems

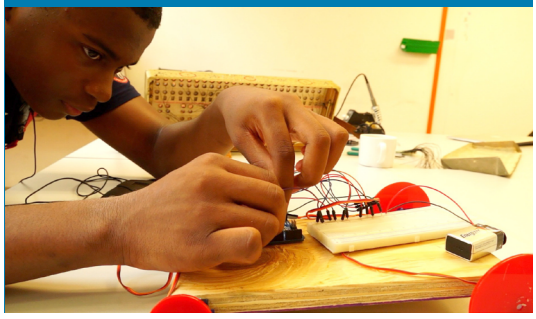
- **Most of today's learning ecosystems are organized by and for members of dominant cultural groups. Broadening participation in STEM will require intentional engineering of new STEM learning ecosystems that help youth, adults, and families historically underrepresented in STEM to recognize, choose, and follow up on productive STEM engagement opportunities.**
- **ISE and science communication professionals can play pivotal roles in helping to broker (connect) their audiences to future or ongoing opportunities to expand their engagement.**
- **Developing programs with and in local communities is a productive way to develop relevant and connected STEM learning ecosystems.**

Truly expanding and diversifying STEM participation will take coordinated and comprehensive efforts to create seamless systems of support. Research shows that most people who successfully pursue STEM engagement and careers have grown up in families and communities that include a variety of role models and mentors; have been exposed to strong, innovative STEM programs in and out of school; and have had access to STEM-rich cultural institutions—like museums and science centers—and to resources such as films, journalism, and social media (Engberg & Wolniak, 2013). For white, college-educated, middle-class families, these systems operate as an invisible infrastructure underpinning what can appear to be individual choices and experiences. People who grow up interacting with and making use of these resources then repeat or replicate them for their own children. In this sense, STEM learning opportunities are already socially and somewhat seamlessly coordinated for many members of dominant cultural groups.

But for many communities historically excluded from STEM fields, including immigrant families new to the US, opportunities to engage in STEM, social networks to support STEM participation, and an understanding of how to navigate the ecosystem of STEM engagement opportunities remain elusive and sometimes even invisible.

What is a STEM Learning Ecosystem?

This brief digs into how the historical and social development of a learning ecosystem impacts its forms and possibilities.



This challenge is compounded when existing investments in STEM engagement opportunities remain siloed and uncoordinated across the STEM learning ecosystem. A lack of coordination leads to missed opportunities.

Public engagement with STEM programs could have stronger impacts for the public if they intentionally connected with and reinforced one another. They could both stake out new territory when such opportunities are not available elsewhere and reinforce or extend existing opportunities, whether in or out of school. For example, understanding the kinds of science in which young people engage at school at different age levels can help program staff to identify ways to reinforce key conceptual areas or cross-cutting themes. Programs that allow young people to deepen their scientific or computational thinking skills and practices can be applied in multiple settings.

Coordinating STEM engagement opportunities means not only designing in ways that intentionally connect to other opportunities but also intentionally brokering participation across organizations and settings. To do so, program leaders must know what others in the community offer, collaborate with other organizations, and refer participants —either directly or through their parents or adult caregivers—to one another's programs and organizations.

How Can We Re-Think Our Assumptions About Parent Engagement?

Parents support their child(ren)'s learning in diverse, and sometimes not visible ways. This brief suggests how to engage parents as critical allies in programs/efforts to engage young people in STEM learning.

STEM Pathways

The term "ecosystems" usually refers to natural environments that vary by climate, geological make-up, and the specific species of trees, plants, and animals that populate the ecology. The elements in the ecology have a dynamic relationship—if one set of elements begins to change, the effects ripple across the entire ecosystem, whether it is a tropical, desert, forest, or other ecosystem.

STEM learning ecosystems are similar: They are made up of organizations and institutions, as well as people, natural resources, and social histories that interact dynamically to shape opportunities to learn STEM. Some STEM learning ecosystems are very rich: They have many places and people who can support STEM learning. Some are fragile: Few places and people support STEM; if one of them disappears or changes, there can be adverse ripple effects in the ecology of STEM learning opportunities.

Like their counterparts in nature, healthy STEM learning ecosystems are characterized by diversity, redundancy, and local adaptation. Efforts to strengthen STEM learning ecosystems focus both on building out the ecosystem—creating more and better opportunities for learning—and on helping learners navigate the ecosystem by ensuring that they can find and pursue ongoing opportunities to expand their participation in STEM.

Efforts to connect people of all ages with emerging STEM research that are directly relevant to current community or social issues can open doors to deepen engagement with both STEM and related community issues. For example, the STEM Ambassadors program (www.stemap.org), based at the University of Utah, prepares scientists studying bird migration to engage truck drivers at truck stops, where both can connect their observations of changing landscapes and weather systems with seasonal bird migrations. The program has also placed materials scientists at sports clothing stores, where they can explain the science behind apparel choices to shoppers. This program seeks to place opportunities to engage with scientists into the everyday social life, reaching audiences who may not previously have chosen to attend a science talk at a university or museum.

Leading Reflective Conversations

As you think about and engage your colleagues or trainees in the issues raised in this section, you might want to be sure that you understand the role that you/they play in your/their local STEM learning ecosystem. What specific experiences are brought to the community? How do these experiences connect to past, present, or future opportunities? How are participants helped to make those connections when they may not have social networks or local knowledge to help them do so themselves?

Questions to consider

- How does your program or organization uniquely contribute to your local STEM learning ecosystem? How does it duplicate or reinforce other opportunities?
- Does your program or organization have a systematic way of connecting with other STEM engagement providers so that you are aware of one another's work and can broker connections between organizations?
- Does your program or organization work across levels, including with parents, teachers, and other community leaders?

How Can We Build on Existing Assets Within a Community?

This brief describes an approach to engaging a wide variety of community members, experts, and organizations to do "science that matters."

How Do We Position Our Broadening Participation Work?

Priorities and Peripheries

- **Retrofitting equity and inclusion approaches onto organizations that were not designed for such purposes is challenging and requires extensive and extended attention.**
- **Leaders of equity efforts often come from communities that have been historically marginalized; when equity is not deeply and comprehensively embraced by the organization, it is common for these leaders to feel marginalized within the organization even as they are seeking to better connect with and support marginalized communities for the organization.**
- **Prioritizing broadening participation means addressing mission, staffing, support, stakeholders, and programming across the organization. Cultivating close relationships with community organizations can help begin to make cultural shifts, especially when these relationships are vertically integrated into the organization and not isolated within one division or person.**

Leaders must ask themselves where broadening participation fits into the scheme of things. If an organization or program was not founded on principles of inclusion and equity, it may be challenging not only to realign the program design but also to get staff to think about whether and how the work should be re-oriented towards broadening participation. Challenging long-held organizational norms and patterns is always difficult. It is particularly difficult when people who have been successful in long-established ways of operating cannot recognize how those ways might have been working against efforts to broaden participation, even though they might have worked well for dominant and privileged communities. The solution is to position this realignment not as an either/or, but as a way of strengthening programs' reach, value, and impact.

Many times, particularly when programs and organizations are attempting to "retrofit" in order to be more inclusive, efforts to broaden participation are positioned as add-ons. They are often led by individuals and not necessarily supported by the institution as a whole. They are frequently supported by special

How Can Institutions Model Inclusion in the Workplace?

This brief surfaces how an organization might be replicating dominant cultural norms and excluding certain groups.

funding streams that will eventually dry up. In other words, they are not deeply prioritized. This lack of prioritization often leads to discontinuities and a lack of coherence. It can also demoralize staff who are committed to broadening participation. Staff who work for inclusion, who are themselves more likely to be from non-dominant communities, can experience marginalization, and even hostility or microaggression, from others who see broadening participation either as competing for resources or as being unnecessarily tacked on to "core" work. Thus, a program or organization can be working against its explicit goals for equity and inclusion when efforts are not centrally prioritized. It has become common wisdom that many such efforts fail or dissipate. To enable sustainable and meaningful shifts in practice, institutions must also shift their cultures.

Programs to broaden participation cannot work when institutions take a narrow view of what counts as STEM—for example, if they replicate dominant cultural norms of STEM, fail to recognize the many ways in which STEM is already used in various communities and everyday settings, and miss opportunities to position STEM as a tool for understanding or addressing community issues that may not be seen on the surface as involving STEM. These views can counteract the positive outcomes of focused project or program efforts to broaden participation. For example, if a community outreach effort brings new cultural groups to a science festival or museum, but then fails to include scientists and STEM professionals from those groups, or positions successful participation as involving scientific argumentation practices that are not familiar or comfortable to those groups, then the experiences are not likely have positive short-term or long-term impacts.

Programs and organizations that seek to make broadening participation a priority will take a holistic approach that not only considers public-facing activities, but also examines internal organizational culture and structures that either impede or foster inclusive practices. They will make inclusion explicit in strategic plans that build in accountability, hire diverse staff, write inclusive mission and vision statements, and have diverse board members and trustees. Leaders will also work to create safe spaces where staff can begin to examine organizational norms and their own unconscious biases, learn to identify and counteract daily microaggressions against staff from non-dominant communities, and articulate what an inclusive organizational culture looks like. This approach does not imply that all

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ideas are good ideas or that all voices have equal authority. It does ensure, however, that all voices are heard and that all ideas are considered through the lens of the organization's goal to broaden participation, in alignment with other organizational goals and priorities.

Creating safe and open dialogue within an organization is a first step towards identifying how to work closely with communities outside the organization. Rewriting the mission and goals to integrate—not simply add on—equity and inclusion in meaningful ways can show leaders where and how shifts can be made.

Listening tours with community groups can help leaders better understand those groups' interests and priorities. Leaders can also develop relationships by inviting community groups or members to present community expert knowledge and work to staff. They can attend community groups' events and activities, creating opportunities for social interactions and building trust. Relationships built on trust serve as the foundation for the co-creation of projects and programs that can truly leverage community norms and interests and can deeply engage community participation.

What Does Working "With" (not "For") Our Communities Look Like?

This brief offers a set of principles that can guide an equitable co-design process that honors a community's strengths, expertise, and insights.

Reflecting on practice

You can arrive at positive actions and decisions for your program or organization only through a process of reflecting on how you currently do or do not conceptualize and prioritize broadening participation.

Questions to consider

- What are your program's or organization's main efforts to broaden participation in STEM? Are these practices led or driven by an individual, such that, if that individual were to leave, attention to these practices would disappear?
- How does your mission statement integrate, in every sentence or goal, a commitment to broadening participation (rather than adding it on as an additional goal)? How is this commitment modelled in your organization?
- Does the language in your equity policy focus on "repairing" individuals or the system?

Taking Action in Your Own Organization

In this report, the CAISE Broadening Participation Task Force joins others in suggesting that the public engagement with STEM sector needs to invest in a more critical and comprehensive approach to broadening participation. We have argued for a need to transform public engagement with STEM work—at scale—so that these important experiences and settings are at the table and centrally involved in collective efforts to broaden participation. Examining our own practices shifts the burden for change from individuals historically excluded from STEM to those who design and lead public engagement with STEM programs. Many organizations and programs have begun to reflect critically on how their work reproduces or disrupts patterns of participation in STEM.

A toolkit to support reflection

The task force created a set of companion resources to this report:

- A **summary** for **stakeholders**
- A set of topical **practice briefs** for staff discussion and reflection,
- A **conversation guide** to help facilitate discussions about ideas found in the report and briefs.

Start with the Toolkit Overview for a full resource list and suggestions for how you might use them to drive action. All resources are available here: informalscience.org/broadening-perspectives.

The next steps

These resources are meant to support leaders who are tasked with (or desire to) develop intentional, strategic, and prioritized efforts to broaden participation in STEM. How you make changes in your program and organization will depend on your different immediate and long-term needs. Answers to questions about why, how, when, and where you design and prioritize your engagement efforts will lead to changes across multiple dimensions of your work. They could lead to changes in the following:

- Hiring and staffing practices
- The ways you delegate or distribute responsibilities
- How you design and implement public engagement with STEM activities
- How you partner and work with local communities, both organizational peers and the communities that have traditionally been excluded from STEM.

We invite you to share reactions and snapshots on social media using the hashtag #broadeningperspectives, and share stories with us directly at caise@informalscience.org.

Members of the CAISE Broadening Participation Task Force

PHOTO CREDIT: M. CHOI

During 2017 and 2018, CAISE convened a task force of 15 leaders in science communication and informal STEM education to identify challenges and opportunities that the public engagement with STEM sector faces in contributing to systemic efforts to broaden participation in STEM. The task force was developed through a process of interviewing field leaders, NSF program officers, and others to identify a blend of long-time and emerging leaders in the fields of science communication and ISE whose work focuses on broadening participation in STEM.

As we charted a course of action to produce the professional development resources described in this report, we identified additional professional colleagues whose expertise and experience in broadening participation positioned them to work with task force members to develop the practice briefs and the noticing tools that accompany this report.

The task force consulted and collaborated with these additional contributors at various points in its work, including through conference sessions, webinars, and brief production workshops. This iterative "snowballing" process of phone, online, and in-person discussions and writing workshops was designed to support our collective efforts to address the urgent challenge of broadening participation in STEM for all citizens.

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References

Banks, J., Au, K., Ball, A., Bell, P., Gordon, E., Guitierrez, K., ...Zhou, M. (2007). *Learning in and out of school in diverse environments: Life-long, Life-wide, Life-deep.* Seattle, WA: The LIFE Center, University of Washington, Stanford University, SRI International and Center for Multicultural Education, University of Washington. https://www.informalscience.org/learning-and-out-school-diverse-environments-life-long-life-wide-life-deep

Birmingham & Calabrese Barton, A. (2014). Putting on a green carnival: Youth taking educated action on socioscientific issues. *Journal of Research in Science Teaching, 51*(3), 286-314. https://www.informalscience.org/putting-green-carnival-youth-taking-educated-action-socioscientific-issues

Calabrese Barton, A., & Tan, E. (2010). We be burnin'! Agency, identity, and science learning. *Journal of the Learning Sciences, 19*(2), 187–229. https://www.informalscience.org/we-be-burnin-agency-identity-and-science-learning

Calabrese Barton, A., Kang, H., Tan, E., O'Neill, T. B., Bautista-Guerra, J., & Brecklin, C. (2013). Crafting a future in science: Tracing middle school girls' identity work over time and space. *American Educational Research Journal, 50*(1), 37–75.

Cannady, M. A., Greenwald, E., & Harris, K. N. (2014). Problematizing the STEM pipeline metaphor: Is the STEM pipeline metaphor serving our students and the STEM workforce? *Science Education, 98*(3), 443–460.

COSMOS Corporation. (1998). *A report on the evaluation of the National Science Foundation's Informal Science Education program.* https://www.informalscience.org/report-evaluation-national-science-foundations-informal-science-education-program

Engberg, M., & Wolniak, G. C. (2013). College student pathways to the STEM disciplines. *Teachers College Record, 115*(1).

Dawson, E. (2014). "Not designed for us:" How science museums and science centers socially exclude low-income, minority ethnic groups. *Science Education, 98*(6), 981–1008. https://www.informalscience.org/not-designed-us-how-science-museums-and-science-centers-socially-exclude-low-income-minority-ethnic

Dawson, E. (2017). Social justice and out-of-school science learning: Examining equity in science television and science clubs. *Science Education, 101*(4), 539–547. doi:10.1002/sce.21288

Duncan, G. J., & Murname, R. J. (2011). *Whither opportunity? Rising inequality and the uncertain life chances of low-income children.* New York, NY: Russell Sage.

Falk, J. H., & Dierking, L. D. (2010). The 95 percent solution: School is not where most Americans learn most of their science. *American Scientist, 98*(6), 486–493. http://www.informalscience.org/95-percent-solution-school-not-where-most-americans-learn-most-their-science

Feinstein, N. W., & Meshoulam, D. (2014). Science for what public? Addressing equity in American science museums and science centers. *Journal of Research in Science Teaching, 51*(3), 368–394. https://onlinelibrary.wiley.com/doi/full/10.1002/tea.21130

Haklay, M. (2013). Citizen science and volunteered geographic information: Overview and typology of participation. In D. Sui, S. Elwood, & M. Goodchild (Eds.), *Crowdsourcing geographic knowledge.* Dordrecht, Netherlands: Springer.

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, W., Rhodes, J., Salen, K., . . . Sefton-Green, J. (2012). *Connected learning: An agenda for research and design.* https://dmlhub.net/publications/connected-learning-agenda-for-research-and-design

Medin, D. L., & Bang, M. (2014). *Who's asking? Native science, western science, and science education.* Cambridge, MA: Massachusetts Institute of Technology Press.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future.* Washington, DC: The National Academies Press. https://doi.org/10.17226/11463

National Academies of Sciences, Engineering, and Medicine. (2016). *Science literacy: Concepts, contexts, and consequences.* Washington, DC: National Academies Press. https://doi.org/10.17226/23595

National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits.* Washington, DC: National Academies Press. https://doi.org/10.17226/12190

National Research Council. (2015). *Identifying and supporting productive STEM programs in out-of-school settings.* Washington, DC: National Academies Press. https://doi.org/10.17226/21740

National Science Foundation. (2018). *NSF INCLUDES report to the nation.* https://www.nsf.gov/news/special_reports/nsfincludes/index.jsp

Pandya, R. E. (2012). A framework for engaging diverse communities in citizen science in the US. *Frontiers in Ecology and the Environment, 10*(6), 314–317. https://esajournals.onlinelibrary.wiley.com/doi/10.1890/120007

Tan, E., & Faircloth, B. (2016). "I come because I make toy:" Examining nodes of criticality in an afterschool Science and Engineering (SE) Club with refugee youth. In S. Marx (Ed.), *Qualitative Research in STEM: Studies of Equity, Access, and Innovation.* New York, NY: Routledge.

Theobald, E. J., Ettinger, A. K., Burgess, H., DeBey, L. B., Footen, N., Froehlich, H., . . . Parrish, J. K. (2015). Global change and local solutions: Tapping the unrealized potential of citizen science for biodiversity research. *Biological Conservation, 181,* 236–244.

Vossoughi, S., Hooper, P., & Escudé, M. (2016). Making through the lens of culture and power: Towards transformative visions for educational equity. *Harvard Educational Review, 86*(2), 206–232. https://www.informalscience.org/making-through-lens-culture-and-power-toward-transformative-visions-educational-equity

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How Can Our Efforts in Public Engagement with Science Be Made More Inclusive?

A Summary for Stakeholders

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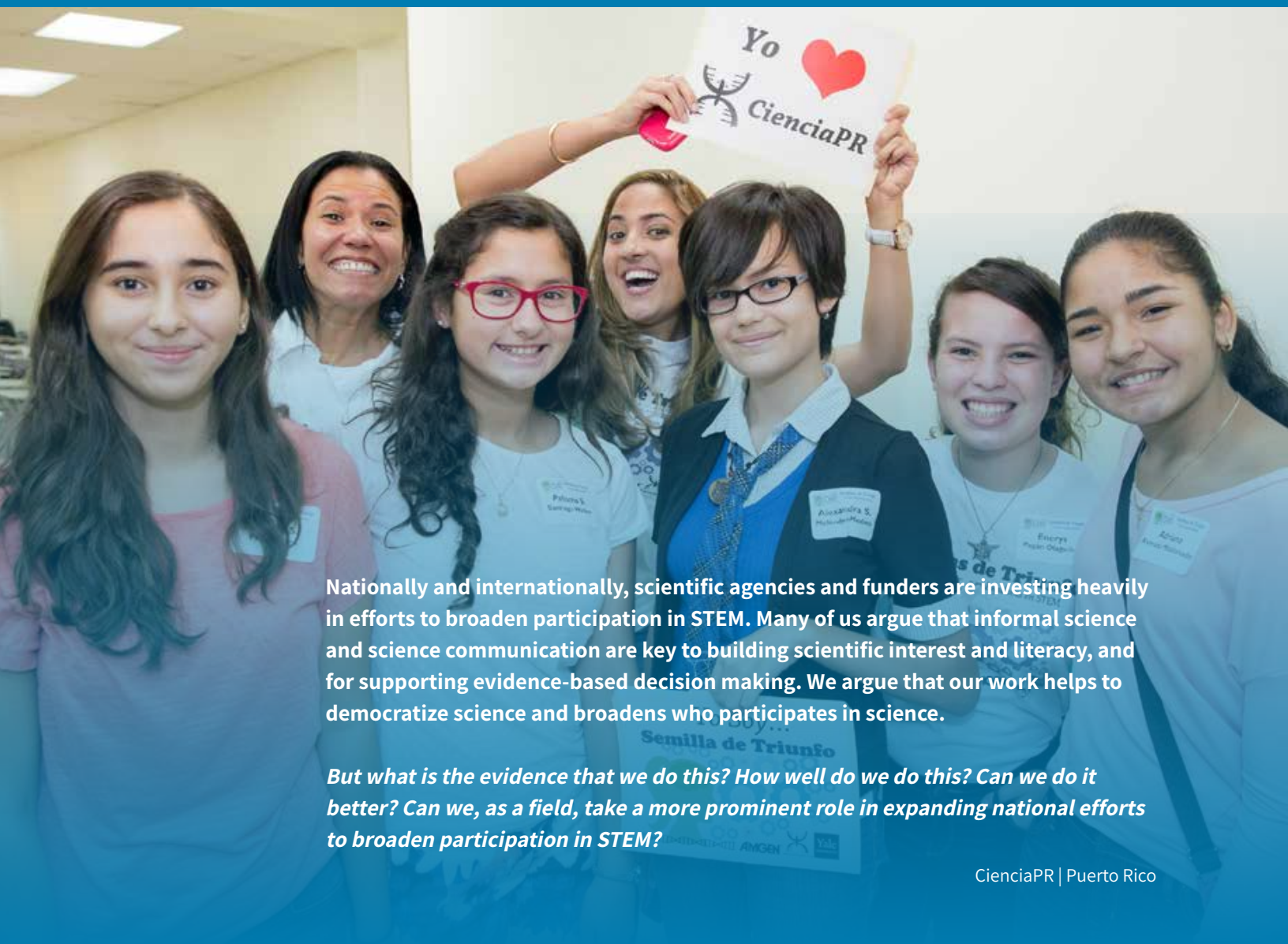

Nationally and internationally, scientific agencies and funders are investing heavily in efforts to broaden participation in STEM. Many of us argue that informal science and science communication are key to building scientific interest and literacy, and for supporting evidence-based decision making. We argue that our work helps to democratize science and broadens who participates in science.

But what is the evidence that we do this? How well do we do this? Can we do it better? Can we, as a field, take a more prominent role in expanding national efforts to broaden participation in STEM?

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Initiating Staff Reflection and Discussion

One step toward answering these questions in ways that align with institutional priorities is to consider more deeply and strategically what broadening participation means in your community, and how your programs or efforts can be shifted to be more inclusive.

Toward these ends, in 2017 the Center for Advancement of Informal Science Education (CAISE) convened a group of 15 science communication and informal STEM education experts—both practitioners and researchers—to identify key barriers that keep our fields from being "at the table" in more than a peripheral way when communities seek to make real change in science engagement.

The task force produced a set of conversation guides and resources to support reflective conversations among professionals seeking to identify areas for growth and change. These conversations could be as small as a series of three 90-minute meetings to a longer arc that is seen as a starting point for further development and investment in broadening participation.

A list of task force members and contributors can be found here: informalscience.org/bp-task-force

Using Professional Learning Resources

The task force developed a report, *Broadening Perspectives on Broadening Participation in STEM*, that summarizes five key topics that the field needs to grapple with in order to make progress—at scale—towards sustained and impactful broaden participation in STEM efforts. These include:

1. The public engagement sector should, but currently does not, play a vital role in broadening participation in STEM.
2. The public engagement sector could advance more compelling reasons for why people historically underrepresented in STEM fields should choose STEM.
3. The public engagement sector could make a stronger effort to disrupt the dominant cultural norms of STEM (which are white, male, and western) to show how STEM relates to and can be advanced through other cultural ways of knowing and being.
4. The public engagement sector could strive to be better integrated and connected with the broader local STEM learning ecosystem, and design programs that explicitly and intentionally help advance people's STEM activities within those ecosystems.
5. Broadening participation, equity, and inclusion work needs to be positioned as core to the organization's mission and success, and not tacked on or siloed within an organization or program.

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To support reflective conversations that address the issues above, the task force also developed a set of "practice briefs" that can serve as advance readings.

These reflective conversations are meant to lead to new insights about if and how our programs or practices are challenging or reinforcing patterns of who participates in STEM. The goal is to help participants clarify specific action steps they can take to make programs more inclusive, to develop a culture of reflective inquiry, and a commitment to broadening participation in ways that make sense in your local organization and context.

PHOTO CREDIT: RESEARCH + PRACTICE COLLABORATORY

Supporting Your Staff

Making progress on broadening participation in STEM also requires us to look at our organizational practices. Often, organizational norms (particularly in long-established organizations) work against efforts to change and expand who participates in, contributes to, and benefits from our work. Leaders of training programs, as well as organizations and large divisions and departments, may also want to consider how these issues apply to their choices.

Informal educators who champion broadening participation efforts, for example, often report that they feel marginalized in their institutions. Their work is sometimes treated as an afterthought, or even an annoyance. Frequently they feel that they are token representatives within organizations that are structurally resistant to change, despite the best of intentions. Efforts undertaken by your staff can provide you opportunities, at the organizational leadership level, to reflect on how your organization is structured to advance or confound efforts to broaden participation.

This can lead to positive organizational changes that can position your institution to both support and lead broadening participation efforts.

We encourage you to support your staff leaders to hold reflective conversations with their colleagues or teams to explore if and how their programs and efforts can be made more inclusive. Supporting your staff means creating the time for them to plan and hold meetings; it also means creating the expectation of and fostering interest in reviewing results, including possible recommendations for changes in current practices.

Decades of research show that reflection on practice will deepen the capacity and expertise of your staff, better positioning your institution to play a stronger role in your community as a champion of a more inclusive and equitable approach to science engagement. This process will also build the capacity and potential of your organization as a whole.

This material is based on work supported by the National Science Foundation (NSF) under award no. DRL-1612739. Any opinions, findings, and conclusions or recommendations expressed in the material are those of the authors and do not necessarily reflect the views of NSF.

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Conversation Guide

PHOTO CREDIT: RESEARCH + PRACTICE COLLABORATORY

Effectively broadening participation starts by examining our own practices. This shifts the burden for change from individuals historically excluded from STEM to those who design and lead public engagement with STEM programs. Many organizations and programs have begun to reflect critically on how their work reproduces or disrupts patterns of participation in STEM. The CAISE Broadening Participation in STEM task force identified five key, overarching challenges leaders must work toward addressing:

1. Recognizing the importance of reflecting on and possibly reframing your efforts to broaden participation through adopting a more critical stance about what can lead to lasting change.
2. Clarifying what "broadening participation" means to your program or organization.
3. Recognizing whether and how your program or organization reproduces dominant cultural norms of STEM or adopts more inclusive approaches.
4. Identifying whether and how your program or organization is truly prioritizing efforts to broaden participation, and what it means if you are not.
5. Understanding how your efforts to broaden participation strategically enrich and contribute to your local systems of STEM learning and engagement opportunities.

The challenges require that leaders and staff closely examine what they do, why, how, and with whom. To support this self-examination, over time, there are a multitude of reflection questions within the *Broadening Perspectives on Broadening Participation in STEM* report, the practice briefs, and on the next page. As a staff leader or trainer, make sure carefully consider which questions to ask and *when*.

Additional Questions to Facilitate Conversations

1. **What is our organization's vision of and goals for "broadening participation" efforts?**
   - How is our vision reflected across the organization?
   - Are our efforts confined to a particular individual or department or is there evidence that we embrace them across our institution?
2. **How well do our programs and offerings align with our broadening participation vision?**
   - Who is not participating and what can we learn about these groups' interests, concerns, and everyday experiences that may be areas we could connect to?
3. **In what ways do our organization and programs/offerings consider the experiences of diverse groups?**
   - What are some ways our organization or programs inadvertently reinforce dominant cultural norms (e.g., ways of speaking, interacting, and assumptions about experiences participants have)?
   - How might we work to design our offerings in ways that honor and utilize diverse participants' everyday and cultural knowledge?
4. **What role does our organization play in the local or regional STEM learning ecosystem?**
   - What are the unique contributions our organization brings?
   - Where might we reinforce or duplicate the efforts of other organizations?
   - Are we connecting with other STEM providers in ways that leverage each institutions' strengths, collaborating to address broadening participation?

Tips for Facilitating Conversations

1. Provide a clear description of the focus of the conversation so that participants understand the goals of the discussion.
2. Try to create an environment that is welcoming and where individuals feel safe, comfortable, and valued as contributors and learners. You might stress, for example, that there are no right or wrong answers and that all ideas and perspectives are important.
3. Encourage everyone to speak, and find ways for all participants to contribute their ideas and perspectives. For example, introduce a question and have everyone jot down their ideas on post-its for five minutes and then share with the group. Try pair discussions for five to ten minutes and then share in a larger group discussion. Pause and encourage those who have not yet talked to offer their ideas.
4. Give people time to think after you pose a question or as people build on each other's ideas. Be comfortable with silence.
5. Use prompts, seek feedback, and encourage others to contribute and build on each other's ideas.
6. Establish a process that honors differences and encourages communication. For example, you might ask for other points of view on a topic.

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Why Broaden Perspectives on Broadening Participation in STEM?

By Bronwyn Bevan, Angela Calabrese Barton, and Cecilia Garibay

What Is the Issue?

There is widespread agreement about the urgent need to broaden the diversity of people who participate in, contribute to, and benefit from science, technology, engineering, and math (STEM). The persistent underrepresented of a large segment of our society in STEM academics, professions, and civic decision-making indicates a system-level failure to recognize, nurture, and channel all young people's early interests in STEM into longer-term pursuits or to adopt inclusive approaches for adults participating in STEM engagement activities.

Though many communities are now undertaking collective efforts to transform who participates in STEM, the informal science education and science communication sectors are largely peripheral to these initiatives (for example, less than 10% of NSF INCLUDES projects focus on out-of-school STEM experiences). Rather than assuming the exclusion is an oversight, a task force assembled by the Center for the Advancement of Informal STEM Education (CAISE) spent 18 months examining how the public engagement with STEM sector typically presents and represents STEM, and deliberated on whether or not it does so in truly inclusive ways that can contribute to efforts to broaden participation. In this process, the task force identified five main issues that organizations and professionals in the field need to grapple with in order to truly contribute to broadening participation in STEM.

Why It Matters to You

- **Science communicators** and **STEM educators** can formally examine how they organize and implement their work to reflect on whether and how their efforts are challenging or reproducing who participates in STEM.
- **Professional development leaders** and **science communication trainers** can engage their audiences in processes of reflection to ensure that equity and inclusion is central to professional learning.
- **Funders** and other stakeholders can ask ISE and science communication professionals to place equity and inclusion at the center of their work, including by considering the issues raised in this brief.

Things to Consider

1. **The public engagement sector should, but currently does not, play a vital role in broadening participation in STEM.**
   - Informal science education and science communication have been shown to be critical for advancing lifelong engagement with STEM, but these experiences are not taken up equally across our communities.
   - Traditional approaches to "broadening participation" in STEM do not take a critical (an historical, political, or socio-cultural) view of the situation, and while there are wonderful exceptions, at scale the field has not yet "moved the needle."
   - Rather than simply doing "more" of what has failed to take at scale, the public engagement sector could benefit from reframing how it approaches broadening participation.
2. **The public engagement sector could advance more compelling reasons for why people historically underrepresented in STEM fields should choose STEM.**
   - Broadening participation efforts too often adopt narrow views—towards careers "pipelines"— of why people should do STEM, which leaves out many who might otherwise engage with and come to value STEM.
   - Pipeline models do not take into account the broad, meandering, and diverse ways in which people may "find STEM" especially through out-of-school opportunities.
   - Choosing to take up opportunities depends not only on access but on the perceived value of those opportunities for one's history, community, hopes, and desires.
3. **The public engagement sector could make a stronger effort to disrupt the dominant cultural norms of STEM (which are white, male, and western) to show how STEM relates to and can be advanced by other cultural ways of knowing and being .**
   - The cultural norms of STEM in academia and the professions are specific to the communities that have built those enterprises; as such, they can be alienating and unwelcoming to others.
   - Programs that seek to intertwine the cultural norms and practices of their audiences with those of STEM professionals can be seen as more welcoming, can bridge connections, and can deepen engagement.
4. **The public engagement sector could strive to be better integrated and connected with the broader local STEM learning ecosystem, and design programs that explicitly and intentionally help advance people's STEM activities within those ecosystems.**
   - Most of today's learning ecosystems are organized by and for members of dominant cultural groups. Broadening participation in STEM will require intentional engineering of new STEM learning ecosystems that help youth, adults, and families historically underrepresented in STEM to recognize, choose, and follow up on productive STEM engagement opportunities.
   - ISE and science communication professionals can play pivotal roles in helping to broker (connect) their audiences to future or ongoing opportunities to expand their engagement.
   - Developing programs with and in local communities is a productive way to develop relevant and connected STEM learning ecosystems.

Things to Consider (continued)

5. **Broadening participation, equity, and inclusion work needs to be positioned as core to the organization's mission and success, and not tacked on or siloed within an organization or program.**
   - Retrofitting equity and inclusion approaches onto organizations that were not designed for such purposes is challenging and requires extensive and extended attention.
   - Leaders of equity efforts often come from communities that have been historically marginalized. When equity is not deeply and comprehensively embraced by the organization, it is common for these leaders to feel marginalized within the organization even as they are seeking to better connect with and support marginalized communities for the organization.
   - Prioritizing broadening participation means addressing mission, staffing, support, stakeholders, and programming across the organization. Cultivating close relationships with community organizations, especially when these relationships are vertically integrated into the organization and not isolated within one division or person, can help cultural shifts within organizations.

Reflection Questions

- **What is your program's/organization's vision of and goals for "broadening participation" efforts?**
- **How well do your programs/ offerings align with your broadening participation vision? Is this true across the board?**
- **In what ways do your organization and its programs/offerings consider the experiences of diverse groups?**
- **What role does your organization play in the local or regional STEM learning ecosystem?**

Tools You Can Use

Use the *Broadening Perspectives on Broadening Participation in STEM* Toolkit to plan and lead reflective conversations with your colleagues, staff, or professional trainees.
informalscience.org/broadening-perspectives

PHOTO CREDIT: CIENCIAPR | PUERTO RICO | SCIENTISTS AND EDUCATORS PARTICIPATE IN A NEW FLAGSHIP K-12 EDUCATION PROJECT CIENCIA AL SERVICIO DE PUERTO RICO (SCIENCE IN SERVICE OF PUERTO RICO) AS PART OF A CULTURALLY RELEVANT SCIENCE COMMUNICATION WORKSHOP OFFERED TO TEACHERS.

This material is based on work supported by the National Science Foundation (NSF) under award no. DRL-1612739. Any opinions, findings, and conclusions or recommendations expressed in the material are those of the authors and do not necessarily reflect the views of NSF.

What Does Learning Have to Do with Science Communication?

By Bronwyn Bevan and Sunshine Menezes

What Is the Issue?

Learning is a lifelong, life-wide, and life-deep process. People learn in all kinds of situations and settings, all day long, all their lives—in relation to their beliefs, value systems, and cultural perspectives. Learning includes—but is more than—conceptual knowledge or recall. Narrow definitions of learning as consisting only of conceptual knowledge can limit how we engage people with and in STEM. Science communicators and educators can miss opportunities to build on prior knowledge to help people make sense of new ideas and experiences in ways that can guide decision-making as well as future choices. Furthermore, decades of research on learning shed light on how science communicators can make ideas interesting, relevant, and meaningful to learners of all ages and backgrounds.

Things to Consider

Research has revealed that learning is a social, cultural, and contextual process that includes identity, interests, concepts, skills, and values. Learning is a process, rather than an end point. It is a form of human development. The term "learning ecology," coined by Urie Bronfenbrenner in the 1970s, describes the context (the settings, the historical eras, and the social and political milieu) in which learning develops. Learning is cumulative and context-dependent; it can give meaning to even the briefest of encounters. Short-term exposure to new ideas does not happen in a vacuum but rather builds on prior experiences and ideas. People learn by relating new ideas to existing experiences and knowledge systems.

Why It Matters to You

- **Science communicators** can draw on tested educational strategies for engaging audiences with the ideas, phenomena, and meaning of science and scientific enterprises.
- **Leaders of science communication programs or initiatives** can build partnerships with other organizations and individuals in order to intentionally connect learning in those other settings with learning in their own science communication activities.
- **Trainers** can give science communicators insights into how science communication relates to, reinforces, or catalyzes people's ongoing engagement with and learning about a subject or an idea.

Things to Consider (continued)

Learning is also a social process. Though educators often focus on individual learners, it's important to see learning as a social activity that involves people in specific cultural contexts. Within these contexts people develop culturally-relevant resources for and patterns of learning and engagement. Making meaning of ideas (e.g., decision-making and sense-making), can, in some cultural groups, be highly collaborative and explicitly connected to detailed cultural histories, rather than an individualistic act independent of historical contexts.

There are similarities as well as differences across cultural contexts. Simply assuming that your audiences learn in the same way you do—that they have the same motivations, interests, and prior experiences—will undermine efforts to broaden participation in STEM.

Measurement of learning is a complex enterprise. Evidence of learning comes from many sources, including audiences' comments, questions, challenges, and reflections during science communication events. These are signals that learning (sense-making) processes are underway. You can notice these processes at work by the increasing sophistication of participants' questions or ways they are connecting new ideas to prior experiences. These short-term experiences lay the groundwork for future engagement and learning.

Tools You Can Use

See these research briefs from Relating Research to Practice to conceptualize how short-term experiences can play a role in longer-term outcomes: Communicating Science Also Communicates Cultural Orientations (brief #431), A Four-Phase Model of Interest (brief #122), and Everyday Moments Doing Science Shape Interest and Identity (brief #432).

Reflection Questions

- **What are the goals of your science communication activities? Specifically, what outcomes do you seek in terms of changing how participants think, understand, or act? How can you structure your activities to promote this type of learning?**
- **How can you design your activities so that participants have moments to talk with one another to help with their meaning-making?**

Recommended Actions You Can Take

- Design your science communication events in ways that surface participants' existing interests and knowledge, so that you can build on those assets. You can get this input from advance work with knowledgeable community partners or from activities that encourage participants to share their ideas and questions before the program starts.
- Identify your learning goals. Develop goals that focus less on content and more on the implications of the ideas in a larger context, such as community or personal decision-making.
- Create opportunities for participants to reflect on ideas you are sharing. Allow time for them to consider the implications for their communities or for themselves, whether by talking to one another, writing, or using other media.

PHOTO CREDIT: PORTAL TO THE PUBLIC (PHOTO COURTESY OF PACIFIC SCIENCE CENTER | SEATTLE, WA)
PORTAL TO THE PUBLIC WORKSHOPS STRESS THE IMPORTANCE OF DEVELOPING A PERSONAL CONNECTION WITH VISITORS AND RESPONDING TO THEIR INTERESTS.

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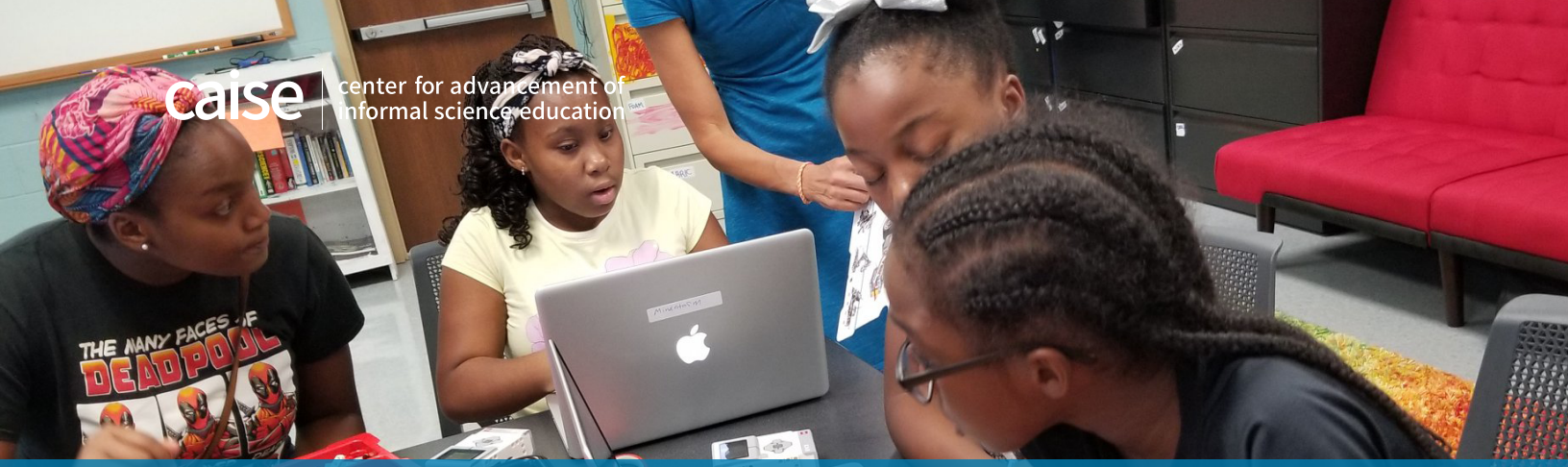

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What Does Asset-Based STEM Learning Look Like?

By Raychelle Burks and Sunshine Menezes

What Is the Issue?

Science communication is often driven by a desire to help people either to become aware of important science research, topics, and ideas or to see how science can be relevant and meaningful to their lives. Research tells us that people learn by building on their prior experiences, understandings, and world views (National Research Council, 2000). However, all social groups have different ways of communicating, interacting, and sharing meanings. They have different views of how the world works. Science communicators and educators need strategies to account for these differences in ways that position differences as strengths, rather than as weaknesses. Those who study science learning and communication have been calling for a shift away from a deficit-based model that focuses on perceived shortcomings to more asset-based models that intentionally leverage people's existing understandings and learning resources as the means for engagement.

Things to Consider

Research shows that learning and engagement in science is a cultural process (Banks et al., 2007). As people learn, they are always—consciously or not—drawing on their existing intellectual, emotional, and social resources to make meaning of new ideas. These resources for learning, or "funds of knowledge," include experiences, understandings, and ways of interacting with the world that people develop not only in school but also in their everyday home and community lives.

Deficit approaches are used when science communicators and educators inadvertently mistake differences (especially differences from their own experiences or perspectives) as the shortcomings of individuals or groups. Perceiving a lack of knowledge and understanding in the audience, science communicators focus on "fixing" the perceived "problem" rather than designing for differences in ways that recognize and build on learners' assets.

Why It Matters to You

- **Science communicators** and **STEM educators** can more effectively engage their audiences by applying asset-based approaches in their activities and strategies.
- **Professional development leaders** and **science communication** trainers can explicitly model asset-based approaches in the training they offer.
- **Funders** can encourage science communicators and informal educators to design their efforts using asset-based approaches.

Things to Consider (continued)

Asset-based approaches recognize that the everyday knowledge, experiences, and cultural practices of audience members are their resources for learning. In fact, standard educational models are designed to build on the learning resources members of dominant cultural groups bring with them to school and other settings. In seeking to broaden participation in STEM, engagement opportunities that leverage people's learning resources (or cultural funds of knowledge) as a means for productive participation have been shown to support deeper engagement.

An important step in developing inclusive science communication and STEM learning experiences is to recognize your own biases and assumptions. The most effective way to design asset-based approaches to science communication and education is to partner with the communities you hope to engage.

Reflection Questions

- **Who are your intended audiences? What do you know about them? How can you come to know them better through authentic, meaningful, community partnerships?**
- **Does your team, staff, or organization reflect the communities you wish to serve? How can you expand your team through new hiring practices or partnerships?**
- **How are you providing opportunities for your audiences to draw on their own learning resources—their everyday and cultural knowledge and practices?**

Recommended Actions You Can Take

Partner with communities to design asset-based programming:

- Build relationships with communities you seek to engage. Learn about their learning resources: their interests, concerns, ideas, everyday knowledge, and cultural practices.
- Work with trusted community members to gather programming ideas. Then co-develop and co-present scientific content and experiences.
- After presenting STEM experiences, reflect and debrief with partners to understand what works and what could be revised.

Design engagement activities using asset-based approaches:

- Draw on the audience's knowledge, experiences, and cultural practices when identifying activity goals and learning outcomes.
- Create opportunities for audience members to suggest how they can apply an activity's STEM content and ideas in ways that are relevant in their lives.
- Prioritize engagement outcomes that foster diverse STEM identities, definitions, interests, and civic engagement.

Tools You Can Use

- This short video from the US Administration for Children and Families describes the concept of Funds of Knowledge.
- These research briefs from Relating Research to Practice offer examples that can guide asset-based approaches: Communicating Science Also Communicates Cultural Orientations (brief #431) and Practitioners' Perceptions of Their Science Engagement Practices (brief #424).

PHOTO CREDIT: GREEN ENERGY TECHNOLOGY IN THE CITY | LANSING, MI
IN THIS COMMUNITY SCIENCE PROGRAM FOR YOUTH, TEENS COLLECT DATA IN ORDER TO ADVOCATE AT CITY HALL FOR LOCAL ENVIRONMENTAL PROTECTIONS.

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What Are the Cultural Norms of STEM and Why Do They Matter?

By Angela Calabrese Barton, Sunshine Menezes, Rabiah Mayas, Olivia Ambrogio, and Melissa Ballard

What Is the Issue?

Current trends in broadening participation tend to emphasize the importance of increasing the number and diversity of people who participate in STEM programs and experiences. However, attention needs to be paid to how people are asked to engage with STEM. The "cultural norms of STEM"—that is, the accepted patterns of practice that make up the standard ways of speaking participating, learning, and working in STEM—can diminish engagement among those who don't fit the "norm."

The dominant cultural norms of STEM are established by the populations that have historically participated in and institutionalized STEM—that is, male, white, western, and privileged.

These dominant norms are characterized by competition, individualism, verbal debate, objectivity, and nature/culture dualities (e.g., animate/inanimate, mind/body, reason/emotion). The norms shape how STEM is practiced, understood, and communicated.

When everybody engaging in STEM is expected to adhere to these dominant cultural norms, some may feel like outsiders, even though others will find them familiar and comfortable. This can shape perceptions about who has expertise and/or belongs in STEM fields. For example, if someone talks and acts in a way that aligns with the cultural norms of STEM, they might be viewed as more "scientific" than someone who does not.

Why It Matters to You

- **Science communicators** and **STEM educators** can consider how the cultural norms reflected in their programs and events include or exclude people (e.g., topics highlighted, experiences provided, and images shared; and stories, examples, languages, and terms used).
- **Journalists** and other **science communicators** can play a powerful role in either maintaining or expanding the cultural norms of STEM. Approaching STEM stories with language and examples from non-dominant groups can expand engagement in STEM to a wider range of people.
- **Funders** can start deliberately rewarding programs that include the knowledge and achievements of non-dominant cultures.
- **Evaluators** can use tools and insights for measuring program successes in ways that extend beyond the dominant cultural norms of STEM.

What is the Issue? (continued)

The dominant cultural norms of STEM are reflected and reinforced in many ways, including through the design of programs or exhibits as well as the common communication approaches of STEM professionals. Well-intentioned STEM professionals who engage in outreach activities to minority groups are often unaware of what can be the alienating effects of using and privileging dominant cultural norms.

Things to Consider

Whether people feel comfortable engaging in STEM is partly a result of their personal experiences and their family and communities' cultural practices. STEM programs and activities must encourage and support participation by leveraging these experiences.

STEM communication plays an important role in the perpetuation (or disruption) of dominant cultural norms. The text, images, and data visualizations all reflect cultural orientations and even biases. Attention should be paid to how STEM is represented in all forms of communication.

Pathways into STEM are often built around implicit dominant cultural norms, but they can and should include entry points, experiences, and directions that incorporate more diverse ways of knowing and being. The inclusion of relevant, real-world themes, incentives for collaboration, representation of multiple perspectives, and examples of cultural knowledge can broaden the cultural norms of STEM in ways that resonate with a wider spectrum of people.

Recommended Actions You Can Take

- Examine the cultural norms that frame participation in your organization's events and programs.
- Monitor the perspectives reflected in your organization's communication documents. What words, images, photographs, and data representations are used, and what do they communicate?
- Implement a process to review the cultural norms expressed in documents before they are released to the public.

Reflection Questions

- **How do events, experiences, exhibits, and displays at your organization represent the lives, experiences, and languages of a diverse audience?**
- **What does it mean to be successful in a STEM experience at your organization? What criteria matter, and how do these criteria align with and/or challenge dominant narratives?**
- **Does your organization employ people from a wide variety of backgrounds who can help expand the cultural norms for STEM education?**
- **What processes does your organization have in place to document the ways in which the dominant cultural norms of STEM drive or frame events, experiences, exhibits, and displays?**

Tools You Can Use

- The Creating a "We" Culture model is a tool for creating a more inclusive culture, and is described in Science and Children (vol. 53, no. 3).
- Two research briefs from Relating Research to Practice may be helpful:
  - This research brief summarizes a study that challenges readers to identify effective ways of communicating information to culturally diverse groups in ways that avoid polarization, particularly in regards to how science and nature are presented in relationship with humans (brief #431).
  - This research brief describes a study of a community-based summer science program with a Native American tribe in order to provide a conceptual framework for addressing culturally based ways of knowing, and supporting students in their navigation of multiple and perhaps conflicting epistemologies (brief #211).

PHOTO CREDIT: H. BURGESS, COASST | PACIFIC NORTHWEST, U.S. AND CANADA COASTAL RESIDENTS GATHER DATA TO SUPPORT MARINE NATURAL RESOURCE MANAGEMENT AND COASTAL CONSERVATION IN THEIR COMMUNITIES.

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What Counts as STEM?

By Melissa Ballard, Marc Lesser, Christine Reich, and Bruno Takahashi

What Is the Issue?

People of all ages and backgrounds participate in science, technology, engineering, and math (STEM) processes and practices on a daily basis, whether they are engaging in chemistry in the kitchen or engineering in the backyard. However, the varied and diverse ways in which people engage with STEM are often not acknowledged due to the historical representation of STEM in school, industry, and society. STEM is often stereotyped as an activity done mostly by individuals who are male, white, and highly intelligent.

These cultural models of "who does STEM" discourage many who don't identify as male and/or white, or who don't see themselves as highly intelligent, from choosing or identifying with STEM. To broaden participation, the field needs to define STEM more comprehensively so that people can recognize the ways they already engage in, use, and contribute to STEM disciplines, even if they don't conform to cultural stereotypes associated with the profession.

Why It Matters to You

- **Science communicators** and **STEM educators** can broaden the appeal of their work by designing programs that recognize and build on the everyday ways people already engage with STEM concepts, phenomena, and practices.
- **Professional development leaders** and **science communication trainers** can help their audiences design ways to make connections between their content and the everyday ways in which people engage with STEM.
- **Funders** can encourage science communicators and informal educators to design programs that incorporate and leverage everyday ways of doing STEM.

Things to Consider

Everyday activities—from taking care of animals to cooking, horticulture, garage mechanics and other activities—involve STEM concepts, phenomena, and reasoning. Research suggests that there are ways to break down barriers and stereotypes that operate to exclude people from choosing STEM (National Research Council, 2015). These include helping people to recognize their knowledge and know-how as aspects of STEM, and designing programs that allow people to make their knowledge the very means for participating in further STEM learning.

Research also finds that STEM must be recognized as more than just concepts and skills (National Research Council, 2010). Science also recognizes particular ways of knowing or reasoning, and particular uses for STEM concepts in the practical world. STEM learning also involves developing an identity with or affinity for STEM, so that learners are recognized—and recognize themselves—as individuals with interest and ability in STEM.

People of all ages—from the youngest children to the oldest adults—can and do participate in STEM learning and practices. All of them bring their prior knowledge, experiences, and skills to the learning process.

Reflection Questions

- **What does STEM look like in your project, program, or institution? Would a broad range of communities see themselves and their histories reflected in this vision of STEM?**
- **How is STEM used by your target audiences as a tool or resource for advancing community interests or social justice?**
- **How can you expand your representations of STEM to include everyday engagement with STEM? Can you expand the view to include STEM-related life choices in such areas as jobs, leisure time, civic engagement, and parenting or mentoring?**

Recommended Actions You Can Take

- When engaging in science communication, be sure to explicitly name the aspects of STEM that are present in many professions and areas of life, such as nursing, construction, and cooking. Connect to a broad range of areas when talking about STEM.
- Work with local communities to design STEM programs that position STEM as a tool to address issues that matter to the communities.
- Tell stories of how you—as a scientist, science educator, or science communicator—came to value and pursue STEM. Were any experiences outside of school pivotal in developing your interests?
- Identify the everyday experiences of your target audiences in order to relate STEM concepts and processes to their needs and interests. These experiences are likely to be specific to the populations or communities you serve.

Tools You Can Use

- This research brief, What do we mean by "equity"? from Relating Research to Practice describes four different ways in which STEM is positioned to support equity: in academic and workplace science, project-based activities, community environmental and other issues, and social justice.
- The FrameWorks Institute has identified patterned ways in which the American public thinks about STEM. First, many people do not know what "STEM" refers to. Second, most people think STEM is for exceptionally smart people, so STEM fields are less important than basic literacy. Their research and resources can help frame STEM as relevant to local communities and stakeholders.

PHOTO CREDIT: CHRIS TEREN PHOTOGRAPHY
NATIVE UNIVERSE: INDIGENOUS VOICE IN SCIENCE MUSEUMS
INDIGENOUS EDUCATION INSTITUTE | SAN JUAN ISLANDS, WA | SCIENCE MUSEUM EDUCATORS PARTICIPATE IN A NATIVE HAWAIIAN HO'OKIPA CEREMONY, A WELCOMING CEREMONY, AT THE HAPAIALI'I HEIAU IN KEAUHOU, KONA, HI.

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How Can We Help Scientists Adopt Equity Approaches to Science Communication?

By Jameela Jafri, Danielle Watt, Rabiah Mayas, Sunshine Menezes, Olivia Ambrogio, Jamie Bell, and Tony Streit

What Is the Issue?

Science communication that connects STEM-based professionals with various publics are often designed and implemented with a range of multiple outcomes in mind. Having specific, articulated behavioral goals and communication objectives can inform strategies for developing impactful activities, settings, and programs. A growing body of recent research shows that strategic goal- and objective-setting can influence the effectiveness of engagement efforts. These findings suggest that scientists and communicators should apply the same rigor used in their research designs to thinking about how their communication objectives align with the engagement strategy. Leaders of professional learning and training in science communication, as well as leaders of informal STEM education programs, can support STEM-based professionals to connect with more diverse audiences by helping them to better understand their own goals for science communication, the audiences who would share or relate to these goals, and how best to reach those goals.

Things to Consider

Scientists and others who seek to engage public audiences with research have varied and sometimes multiple motivations for doing so. Goals such as exciting or informing audiences about STEM are often the tip of the iceberg of the range of possible outcomes of an activity, talk, or other designed strategy. Given that there can be a mix of personal, organizational, and societal goals that motivate a given STEM professional to engage in communication

Why It Matters to You

- **Scientists** and **STEM professionals** can be more effective at engaging diverse audiences if they align their engagement strategies with their communication goals and target audience.
- **Science communicators** can help scientists have more rewarding engagement experiences by better understanding the alignment between goals, strategies, and audiences.
- **Professional development leaders** and **science communication trainers** can design training programs that help science communicators understand the intersection of goals, objectives, strategies, and audiences, and how these elements may vary at different times or for different purposes.

Things to Consider (continued)

or outreach, taking the time to investigate, identify, and articulate desired goals and objectives can be an important step in successful engagement. Goals may include: Generating interest in STEM careers, informing everyday decision making using science, influencing the way STEM is taught in school or afterschool settings, building community support for local science institutions or agencies, or positioning STEM as a tool for supporting community improvement efforts and social justice.

An example of a specific science communication objective—towards, for instance, informing everyday decision-making using science—is building audiences' trust of scientists and the scientific enterprise. The perception that a person is caring and warm are components of building trust, but research has shown that while scientists might already have audiences' respect for their expertise, they are not necessarily seen as caring or warm. Such findings suggest that communication may be more effective when scientists adopt program strategies that make their personal belief systems and their motivations to work for social good more transparent to their audiences.

Reflection Questions

- **What are our program's goals for designing and implementing communication, engagement, and/or STEM learning activities? Do we have both short- and long-term objectives?**
- **What do we know about the goals of our current audiences, or the goals of the audiences we would like to reach?**
- **How can we be more strategic about our designs and activities?**

PHOTO CREDIT: INNA SHNAYDER
GS2018: GUERILLA SCIENCE GATHERING | PRATT INSTITUTE, NEW YORK CITY
SCIENTIST AGNES MOCSY AND THEATRE DIRECTOR DEBY XIADANI EXPLORE WAYS THAT AUDIENCES AND SCIENCE COMMUNICATORS CAN INTERACT IN A WORKSHOP ON INTERACTIVE THEATRE.

Recommended Actions You Can Take

- Identify and map your goals, objectives, and engagement strategies for current and past science communication activities. How could they have been better aligned?
- Identify the goals and interests of your current target audiences. In what ways do they resonate with the goals you have identified for your science communication efforts?
- Be intentional, moving forward, about aligning goals, objectives, audiences, and engagement strategies.

Tools You Can Use

- Two 2016 articles by communication researchers Dudo, Besley and Yuan provide background on goal-setting and why it matters—one on scientists' prioritization of communication objectives for public engagement (doi.org/10.1371/journal.pone.0148867) and the other on the need and use of short term objectives in parallel with long term goals (on the blog of Michigan State University's Department of Advertising and Public Relations).
- A 2014 article by Fiske and Dupree on the role of trust in science communication explores the dimensions of trust and makes a case for why it is as important as respect as a consideration when setting communication goals (doi.org/10.1073/pnas.1317505111).
- Informal STEM education providers and professional associations are trusted sources of STEM information. This 2016 CAISE report provides STEM professionals with an overview of engagement and public participation in scientific research, and a short list of organizations and networks that have resources.
- Portal to the Public helps informal learning organizations utilize and train scientists and engineers to have meaningful conversations with publics around local STEM issues.
- The Role Models Matter toolkit, created by Techbridge Girls, prepares STEM professionals for outreach with girls and underrepresented youth.

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What Is a STEM Learning Ecosystem?

By Bronwyn Bevan, Cecilia Garibay, and Sunshine Menezes

What Is the Issue?

If we think of STEM engagement and learning as taking place only within specific contexts—such as school classrooms or limited time-frame programs—we create a distorted view of how people learn. Research clearly demonstrates that people's interests, understanding, and commitments develop across multiple settings and times. Many communities are adopting a "STEM learning ecosystem" approach to identify and map those settings and time frames, to enrich and reinforce opportunities within them, and to broaden participation in STEM.

Things to Consider

"Learning ecosystems" or "learning ecologies" are constituted by the places, ideas, institutions, and people available to support learning and engagement. The nature of a local STEM learning ecosystem directly affects the availability and quality of opportunities to learn STEM. As with natural ecosystems, learning ecosystems evolve over time; they have human and social histories. How a learning ecosystem developed—who participated, contributed, and benefited in the past—shapes how people perceive and participate in it today.

Robust STEM learning ecosystems go beyond simply making opportunities available; they take histories of inclusion and exclusion into account to ensure that opportunities are inviting, relevant, responsive, and intellectually engaging to all learners. They are intentionally designed to help learners make connections across the ecosystem—to build on what came before,

Why It Matters to You

- **Science communicators** and **STEM educators** can increase the relevance and inclusiveness of their programs by making explicit connections between the programs they offer and additional or ongoing opportunities learners can pursue in the local STEM learning ecosystem.
- **Professional development leaders** and **science communication trainers** can help their audiences position their programs to address gaps in available opportunities within an ecosystem, or conversely, reinforce strengths in the ecosystem.
- **Funders** and other stakeholders need to consider how programs are connected to one another, formally and informally, to enrich the STEM learning ecosystem.

Things to Consider (continued)

on what may be occurring simultaneously in another setting, and towards future opportunities to go deeper and broader with one's interests, skills, and understanding.

Like ecosystems in nature, robust learning ecosystems are characterized by diversity, redundancy, and local adaptation. To thrive, they need to blend multiple, differentiated, and ongoing opportunities for learners to engage and deepen their engagement with STEM. It is critical to avoid creating a monoculture, which ultimately will exclude most learners. Instead, leaders must work to create multiple access points that reflect the range of perspectives, backgrounds, and strengths of the diverse people who inhabit the learning ecosystems.

STEM learning ecosystems, like natural ecosystems, have deep histories that shape the present. In socially constructed systems, histories often relate to power and privilege. It is important to recognize how your local community may have excluded specific groups (by age, race, sex, faith, gender, or other factors) from pursuing STEM tracks in school, from participating in STEM careers, from becoming STEM mentors, or from accessing science lectures, museums, and public nature settings. Naming and confronting these histories can help STEM communicators/educators gain clarity on the need to create learning opportunities that counteract past injustices and create a more inclusive future.

Recommended Actions You Can Take

- Design your science communication and education programs in ways that explicitly build on your audiences' prior experiences.
- Provide explicit guidance to audience members about where they can go to learn or do more. Be sensitive to whether your audiences will feel welcome and included at the places you suggest, so that you provide next steps for all program participants.
- Meet with other STEM providers in your region to explore how your program may connect with, reinforce, supplement, or possibly conflict with their programs.

Reflection Questions

- **Does your program explicitly help participants identify opportunities for further engagement with the program's ideas and experiences?**
- **How do your programs fit within the local STEM learning ecosystem? Who is doing similar work? How is the work different? How does it offer useful or unnecessary redundancies?**
- **Are there important community organizations or actors who are not an active part of the STEM learning ecosystem? Why?**
- **Do all STEM learners—across age, race, sex, and other factors—have access to STEM learning ecosystems in your community? Are there any STEM learning "deserts" in particular neighborhoods, age ranges, abilities, or other sectors?**

Tools You Can Use

- More detailed descriptions of learning ecosystems can be found here: STEM learning ecologies: Relevant, responsive, connected in the *Connected Science Learning* journal and STEM learning ecosystems: Critical approaches in *Spokes* magazine.
- The Hive Research Lab's toolkit, Brokering Youth Pathways, shares techniques for connecting youth to future learning opportunities and resources.
- Use this Funds of Knowledge video and handout from the National Center on Cultural and Linguistic Responsiveness to consider how to engage families within learning ecosystems by building on their cultural funds of knowledge.
- The national STEM Learning Ecosystem initiative provides design principles, strategies, case studies, and other tools from existing local STEM ecosystems across the country.

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How Can We Re-Think Assumptions About Parent Engagement?

By Dale McCreedy, Micaela Balzer, and Bhaskar Upadhyay

What Is the Issue?

Parents, broadly defined as the significant adults in children's lives, have the potential to greatly impact children's participation in STEM. They have insights into their children's interests, activities, and dispositions that can help science communicators/educators make STEM more relevant to children's lives. However, environments that promote collaborative learning experiences for children and adults are rare. Organizations, institutions, or initiatives often do not engage these influential adults as effectively as they might, nor are they always sensitive to the perspectives, needs, and expertise that caregivers bring to the activities in which their children participate.

Things to Consider

Active parent engagement and support of children's learning manifests in different ways, not all of which require parental presence. There are many known challenges with regard to parental engagement in informal STEM learning and science communication opportunities. While some parents eagerly dive in, many may be less comfortable for a range of reasons, such as their own prior negative experiences with STEM; literacy or language challenges; unfamiliarity with the setting; or worldviews or religious orientations that cause hesitation. It is critical that STEM educators and science communicators consider how varied perspectives, values, belief systems, and power dynamics play out in science communication/learning experiences.

It is crucial to consider whether parents are part of the intended audience and if so, how they can participate. Parents are often delegated to the role of bystander, chauffeur, or coat holder; they may come to the experience assuming that it is meant for the child only.

Why It Matters to You

- **STEM educators** and **science communicators** can better support youth when they effectively engage parents in relevant aspects of the work**.**
- **Professional development leaders** and **science communication trainers** can help their audiences recognize the need to work in partnership with organizations that cultivate parent engagement and support.
- **Funders** can encourage programs to identify if and how their impacts could be strengthened through parent engagement.

To better engage parents, explicit invitations and strategic activity designs are critical. For example, adults could be invited to partner with their children or author their own roles, depending on their and their children's interests and needs (e.g., being a facilitator or active observer as their children learn to code).

Tools You Can Use

- Libraries for the 21st Century: It's A Family Thing from the Global Family Research Project includes a research-based framework to guide new initiatives.
- The STEM Next Opportunity Fund's Family Engagement Initiative produces evidence-based practices and case studies.
- Family Creative Learning is a practical guide for hosting a series of workshops that build on families' relationships and cultural backgrounds to strengthen their social support and competence in using computers.
- Harnessing the Power of Explanation: Talking to Schools and Families About Afterschool STEM can help staff who work directly with families on how to communicate the benefits of STEM learning.
- Engaging Parents, Developing Leaders: A Self-Assessment and Planning Tool for Nonprofits and Schools from the Annie E. Casey Foundation can help to assess organizational success.

Reflection Questions

- **What roles do parents have in your programs? How might those roles be expanded? How might parents author their own roles?**
- **How are you engaging parents in multiple and culturally relevant ways? How might your approach exclude certain parents?**
- **How does your organization get to know parents better, including: their goals for their children; the challenges they face with respect to engagement in STEM; and their cultural assets?**
- **Does your organization partner with community-based organizations that have already established parents' trust?**

PHOTO CREDIT: RICAROSE ROQUE, FAMILY CREATIVE LEARNING | BOULDER, CO
ELEMENTARY SCHOOL STUDENTS AND THEIR PARENTS LEARN TOGETHER,
USING CREATIVE TECHNOLOGIES IN A SERIES OF EVENING WORKSHOPS.

Recommended Actions You Can Take

Cultivate parent engagement:

- Identify a trusted community liaison that will help provide community insights, access, and validation leading to parent participation and contribution.
- Go to where parents and caregivers are (children's performances, community events, faith-based programs, back to school night, etc.).
- Seek to understand parents' goals for their children, and the roles they already play.
- Seek and validate input in ways that build trust, recognize expertise and assets, and create mutually beneficial relationships.
- Provide clarity on, and support for, roles and expectations for parents.

Design learning experiences that:

- Draw on parent input from the beginning.
- Bring families and children together (e.g., sharing meals, working on projects together, and sharing projects with other families).
- Communicate the value of engaging in non-STEM enrichment opportunities together, such as supporting family bonds and connectedness.
- Recognize and address possible parent inhibitions or constraints (logistics, fear of failure, lack of knowledge, unclear roles).
- Develop activities that draw upon everyday knowledge and the cultural practices of the intended audience.
- Provide tools to build confidence and support learning—posit questions parents might ask, list expectations and roles, translate materials, etc.
- Embed strategies that move parents from the periphery, to managing supportive tasks and engaging collaboratively in the learning process.
- Include supportive materials as part of the learning experience—post questions parents can use, definitions, and reminders of the exploration process you are promoting.

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How Can We Build on Existing Assets Within a Community?

By Angela Calabrese Barton, Edna Tan, Daniel Birmingham, and Carmen Turner

What Is the Issue?

To broaden participation in STEM, many argue for a need to work *with*, not *for*, communities. Co-developed with community groups and organizations, "community science programs" are events and programs located in the community itself, and not in a university, museum, or other institutional setting. As such, they are designed by community members to advance community priorities, and are therefore more likely to be taken up and sustained over time. These efforts recognize that communities themselves—not just the nearby universities or research labs—are rich with people, resources, and practices that make up science in everyday life.

Things to Consider

Science educators and communicators must value and appreciate science that already takes place in the community, which may look different than traditional (school-like) representations of science, which have historically excluded many communities.

Research shows that young people's desire to learn and do science that matters in their lives and in their communities cannot be separated from who they are, what they care about, and what positive difference they hope to make in their worlds. By building on existing resources and practices within the community, science communication/education events or activities can be designed to position science as a tool for these transformational goals.

Why It Matters to You

- **Science communicators** and **STEM educators** can enrich their contributions to the community by working with community members to design events/programs that advance community priorities.
- **Professional development leaders** and **science communication trainers** can help participants develop strategies for connecting with local community organizations and networks.
- **Funders** can reward programs that incorporate community resources and knowledge into STEM offerings that position STEM as crucial to social progress.
- **Evaluators** can take community priorities into account as they design measurement strategies.

Things to Consider (continued)

The full and rich lives of community members should be integral to all aspects of program planning, including program design, recruitment, and evaluation. Community stakeholders, including science communicators/educators, can collectively define what counts as science in their communities, who does science, and why. This process can help draw connections between existing community activities and science practices, surface community members with different forms of science expertise, and create new networks that link community members to science-related spaces and resources. Participants in the process can come to recognize that expertise flows in many directions, residing in community spaces as well as in more traditional science-related spaces, and that each can aid the other.

Reflection Questions

- **Does your program or organization currently work "with" (not only "for") your community? What does this mean to you? What does this look like?**
- **What are major community concerns right now and how might science address those concerns or advance community priorities?**
- **Which community members, networks, or organizations would be important to include in developing a plan for community science?**

Recommended Actions You Can Take

- Conduct "community asset mapping" to learn more about the people, resources, and contexts that matter to people in the community. Invite people of all ages and with varied expertise (for example, the Vietnamese grandmother who gardens) to the mapping conversations and activities. Attend multiple local community organizations' events to get to better know the purpose, people, activities, and possibilities for starting conversations about how STEM is or could be of value in moving towards community priorities.
- Design community engagement in ways that allow multiple perspectives and voices to be heard.
- Consider multiple goals and outcomes of science in community: community workshops, formation of new social networks, transformation of gatekeepers into allies.

Tools You Can Use

- Research briefs from the Relating Research to Practice Project describe studies examining community-based and everyday science including: Kitchen Science (brief #296), Everyday Discourses (brief #110), and Working with Indigenous Communities (brief #357).
- Digital Youth Network's Chicago City of Learning Platform provides one example for documenting, visualizing, and operationalizing a community's ecosystem. Google Maps can also be an effective tool for creating and sharing maps.
- This peer-reviewed article describes "science that matters" to youth in community settings. Themes include engaging in science with a commitment to community; bridging science and place in ways that promote transformation; and challenging barriers to participation in science, including those related to race, class, gender, and age (doi.org/10.1002/sce.21293).

PHOTO CREDIT: CHRIS TEREN PHOTOGRAPHY, NATIVE UNIVERSE: INDIGENOUS VOICE IN SCIENCE MUSEUMS, INDIGENOUS EDUCATION INSTITUTE | SAN JUAN ISLANDS, WA
SCIENCE MUSEUM EDUCATORS LEARN FROM COMMUNITY, LAND, AND SEA, AT THE HAPAIALI'I HEIAU IN KEAUHOU, KONA, HI.

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How Can Institutions Model Inclusion in the Workplace?

By Rabiah Mayas, Danielle Watt, Jory Weintraub, Ann Hernandez, Christine Reich, Sunshine Menezes, and Cecilia Garibay

What Is the Issue?

In recent years, science communication and informal science learning organizations have worked to develop individual programs and educational efforts that focus on ways to better engage communities historically underrepresented in STEM. These efforts are important, but broadening participation efforts need to move beyond the programmatic to the institutional. Embedding inclusion throughout an organization's operations will lead to more comprehensive, better supported, and more impactful and sustainable results.

Things to Consider

Research shows that an organization's culture (the institution's values, beliefs, attitudes, and norms) and structure (how it arranges its staff, jobs, and decision-making processes) drive institutional strategies and practices. In other words, organizational culture and structures determine what matters, what happens, and how it happens.

For example, a STEM after-school program that is inclusive of children with same-sex parents must not only develop an inclusive curriculum but must also include culturally competent staff. It must ensure that administrative functions are aligned, including, for example, that registration or contact forms use inclusive language such as "caregiver/parent." These thoughtful approaches to internal, institutional structures and practices result in more coherent experiences for external audiences.

Why It Matters to You

- **Science communicators** and **STEM educators** can develop programs or event structures (hiring, curriculum, etc.) that reflect institutional priorities.
- **Leadership** and **boards** can champion and support inclusive organizational practices and structures that can, in turn, better position the organization for success in its broadening participation efforts.
- **Funders** can request that programs demonstrate how they have aligned institutional structures and practices with their goals for broadening participation in STEM.

Things to Consider (continued)

Creating truly inclusive environments, where communities historically underrepresented in STEM feel a sense of empowerment, welcome, and belonging, requires that we (a) critically examine the ways our organizations may be replicating dominant culture norms and practices that may exclude certain groups and (b) take steps to ensure that all levels of the organization are working together toward broadening participation.

This includes, for example, examining hiring practices and staff retention, board membership, decision-making processes, random acts of tokenism, and developing cultural competence across the institution.

Reflective practice through self- and external assessments, ongoing professional development and training, benchmarking with peer organizations, and feedback from (and collaboration with) communities who are underrepresented in STEM can deepen cultural competence and inform broadening participation efforts. As organizations or programs deepen their understanding and change their own practices, they can begin to make progress toward equity and inclusion in their communities.

Recommended Actions You Can Take

- Develop and share a clear institutional message about the value the organization places on equity and inclusion. Use this as a starting point to help build common language and foster conversations across the organization.
- Identify organizational strengths and weaknesses and use these to determine areas where there are opportunities to change. A toolkit or checklist can help you explore potential actions such as hiring policies and practices, cultural competence training, and developing work groups who can lead efforts toward more inclusive practices

Reflection Questions

- **How do your current organizational or program structures reflect and advance a commitment to broadening participation in STEM? Where do they fall short, and how?**
- **Who are the audiences and communities you work with? How do your organization's values, experiences, workforce, and culture reflect and meaningfully include these groups?**
- **How can you help staff and volunteers at your organization remain consistently aware of the core values and practices supporting equity and broadening participation?**

Tools You Can Use

- The American Alliance of Museum's *Welcoming Guidelines for Museums* offers concrete ways institutions can become more welcoming to LGBTQ guests and families. The checklist may be adapted for other communities.
- This article in *Dimensions* magazine describes the efforts of two museum leaders tackling issues of equity, diversity, and inclusion in their own institutions (issue 63).
- This article in *Science* describes barriers in undergraduate science programs faced by populations underrepresented in STEM, and provides recommendations for institutions looking to address those issues (volume 357, issue 6356).

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What Does Working "With" (not "For") Our Communities Look Like?

By Dale McCreedy, Nancy Maryboy, Breanne Litts, Tony Streit, and Jameela Jafri

What Is the Issue?

Traditionally, programs designed for community audiences are designed by the STEM institution or organization seeking to "serve" a given community. These top-down design processes are framed by the perspectives of the lead organizations, and typically reinforce dominant cultural norms in STEM and therefore marginalize certain audiences. Instead of building on the community's assets, these programs may ignore, discount, or simplify local contexts, and thus deepen divides between organizations and their communities. Co-design offers an approach that can lead to more robust and sustainable results by developing programs that are culturally responsive, respectful, and inclusive. Co-design with community is not a one-size-fits-all endeavor, but rather a continuum consisting of varying degrees of community involvement. What is most important to remember is that all parties involved have strengths, expertise, and insights that, if honored, will benefit the resulting relationship and strengthen its impact.

Things to Consider

A "community" is a place where people work, play, and interact. A community is a group of people with unique shared values, behaviors, and artifacts. It can be small or broad. It can be a neighborhood. It can be a cultural group or a group with particular historical roots, stories of past trauma, or histories of settlement, immigration, and growth. Co-designing community programs with community members can take into account these histories, priorities, and hopes to design programs that are deeply valued and co-owned by all relevant stakeholders.

Why It Matters to You

- **Science communicators** and **STEM educators** can develop more relevant and sustainable programs through co-design with their communities.
- **Funders** can encourage more sustainable efforts by supporting co-design projects with the extra time and funds needed to establish strong and trusting relationships and solid plans.
- **Evaluators** can develop comprehensive approaches by including the values, validation processes, and success indicators of the community partners.

Things to Consider (continued)

Co-design does not happen without careful relationship building and planning, which takes time. It demands a commitment to drawing upon all stakeholders' expertise. These principles can guide the process.

- Parties who initiate a partnership must take care when they open a dialogue on the need, challenge, or opportunity for working together. They may be surprised to learn that their assumptions are not shared.
- Two-way dialogue requires in-person meetings, both at the institution and in the community.
- Trust does not develop automatically. Relationships need to be built. In addition to time, this takes a willingness to see others' perspectives, questioning assumptions about the perceived benefits and challenges of a partnership, listening deeply, and being open to different approaches.
- Defining and articulating a goal or purpose for the relationship should be a shared process. The process takes place with, not for, the community. New shared understanding may alter the focus of the partnership or even reveal a mismatch. A mismatch should not be viewed as a failure, but rather as a reflection of a deep understanding of one another that can be tapped in the future.
- "Equitable" does not mean "equal." Partners can draw on strengths and resources in many ways, and those ways are not the same. This difference is one reason the partnership exists. Care should be taken to support all partners in recognizing and collaboratively deciding how to balance responsibility, respect, acknowledgement, and funding among partners.
- Advocates, allies, and bridge-builders are required in the co-design process. These individuals are valued and trusted community members who can serve as critical intermediaries between partners.

Reflection Questions

- **To what degree do you currently co-design with community groups?**
- **How do you see co-design work as valuable or challenging? What are or might be the pros and cons?**
- **What strategies does your organization have in place to build trusting relationships with partners in community settings?**

Recommended Actions You Can Take

- Identify and work with allies and brokers to build relationships and new understandings.
- Hold meetings at all partner settings.
- Formally articulate each partner's values and goals to clarify expectations.
- Set up leadership and governance models (e.g., MOUs).
- Commit people, resources, and time towards a long-term co-design process.
- Learn the cultural protocols of the communities you wish to partner with.

Tools You Can Use

- The Research-Practice Partnership toolkit from the Research + Practice Collaboratory has tools for surfacing values and solidifying partnerships.
- The book, Building Communities from the Inside Out offers examples and instructions for asset-based approaches to partnerships.
- Cosmic Serpent: Collaboration with Integrity, from the Indigenous Education Institute, addresses deep listening, examination of biases, and careful reflection.

PHOTO CREDIT: REBECCA TONIETTO, THE PORCH PROJECT | FLINT, MICHIGAN
POLLINATOR FRIENDLY GARDENS ARE PLANTED AND THEN MONITORED FOR SCIENTIFIC RESEARCH IN NEIGHBORHOOD FRONT YARDS ON THE EASTSIDE OF FLINT, MICHIGAN.

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