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Broadening Perspectives on Broadening Participation in STEM

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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).

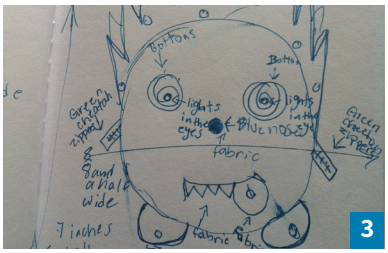
4. The **INSPIRE** project in Utah (nalininadkarni.com/about/science-for-the-incarcerated) is bringing STEM to the incarcerated through lectures, workshops, and conservation projects.

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?

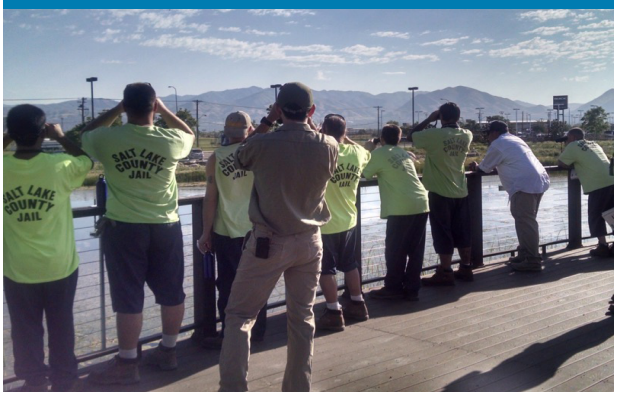
This brief notes the many ways that STEM concepts, phenomena, and practices are encountered or deployed in everyday settings. It suggests that taking a broader view of "what counts" as STEM can be a powerful way for broadening participation in STEM.

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

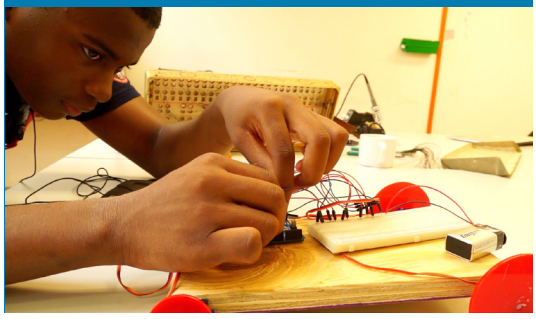
- **Most of today's learning ecosystems are organized by and for members of dominant cultural groups. Broadening participation in STEM will require intentional engineering of new STEM learning ecosystems that help youth, adults, and families historically underrepresented in STEM to recognize, choose, 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

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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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