



Promoting Inclusion and Engagement in STEM Learning: A Practical Guide for Out-of-School-Time Professionals

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*Planetary Learning That Advances the Nexus of
Engineering, Technology, and Science (PLANETS)*

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Contributors

The authors extend their gratitude to those who contributed to the development of this guide at different stages.

Focus Group Participants

Focus group participants were recruited nationally to participate in 90-minute interviews. Participants were out-of-school-time (OST) educators with at least 5 years of experience working with the intended youth. We thank all OST educators who participated in the focus groups. A number of these educators also reviewed this current guide to provide feedback. The following educators assented to the inclusion of their names as contributors:

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- Denise McNamara, OST educator (area of focus: multilingual learners)
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PLANETS expert advisory members supported the PLANETS research team. Each advisory member has expertise in supporting the intended youth audiences focused on in this guide (i.e., Indigenous youth, multilingual learners, and learners experiencing physical and/or sensory disabilities):

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Introduction

Participation in out-of-school-time (OST) programs, especially in science, technology, engineering, and mathematics (STEM), has been shown to be beneficial for youth, particularly youth who are underserved (National Institute on Out-of-School Time [NIOST], 2009; National Research Council, 2015). These benefits include promoting academic success, health and well-being, and identity development (McCombs et al., 2017). Many OST programs and educators seek support for how to promote STEM learning with specific youth audiences, such as Indigenous learners, multilingual learners, and learners experiencing differing physical and/or sensory abilities.

This guide is designed to provide practical strategies and guidance for OST professionals—including educators, program directors, administrators, curriculum developers, professional learning providers, and education researchers—who provide STEM learning activities to youth outside of a formal classroom setting. This OST learning may occur before or after school, on weekends, or during intersession breaks through programming provided by camps, afterschool clubs, or community organizations such as Boys and Girls Clubs.

This guide reflects the collaborative work of WestEd and Northern Arizona

University (NAU) through the Planetary Learning that Advances the Nexus of Engineering, Technology, and Science (PLANETS) program, with support from the National Aeronautics and Space Administration (NASA). In our interactions with OST educators, we regularly found ourselves examining the following statement from the National Research Council’s *Framework for K–12 Science Education* (2012):

Equity in science education requires that all students are provided with equitable opportunities to learn science and become engaged in science and engineering practices.
(p. 28)

This led us to ask, “What does it truly mean to provide STEM education for all learners? What strategies and approaches are most effective for diverse audiences? Who, specifically, are these audiences?”

We attempted to address some of these questions and identify promising practical recommendations by conducting a systematic exploration of OST programs, curricula, and educator support materials. Specifically, in 2021, we (a) conducted an extensive review of the research literature on STEM learning for diverse learners,

(b) convened and interviewed a focus group of 20 OST practitioners who had expertise in STEM learning with diverse learners, and (c) consulted with a group of advisors with extensive experience with our intended learners. We focused on STEM learning for three diverse groups of youth, in particular: *Indigenous learners, multilingual learners, and learners experiencing differing physical and/or sensory abilities*. These learners were intentionally selected to help broaden participation, learning, and engagement in STEM education. See the appendices at the end of this guide, which showcase how this guide has been translated into action in the PLANETS curriculum.

We used two frameworks—Universal Design for Learning (UDL) and culturally sustaining pedagogies (CSP)—to provide an overarching structure for the promising practices shared in this guide. As shown in Figure 1 (p. 4), the promising practices in this guide are organized into the following four categories:

- OST program design (larger program considerations beyond teaching STEM)
- instructional practices (pedagogical strategies used in OST)
- design elements for curriculum materials (the content of what is being taught in STEM OST)
- professional learning practices (professional development for OST educators)

When referring to the data obtained in the literature review, we use the term “research.” When referring to data obtained from focus group interviews, we use the term “educators.” Our overall approach in outlining the recommended practices for OST program design, instructional practices, curriculum materials, and educator professional learning was strengths-based rather than needs- or deficit-based. A strengths-based approach does not ignore individuals’ limitations or challenges. Rather, it goes beyond these to identify the individual and collective strengths learners bring to each new experience (Buntinx, 2013).

About PLANETS

PLANETS is a NASA-funded OST program for educators serving youth in grades 3–8 that facilitates STEM learning with an emphasis on planetary science and engineering. The PLANETS program represents a unique, interdisciplinary, cross-institutional partnership led by STEM educators from the Center for Science Teaching and Learning, Northern Arizona University; WestEd; and the Museum of Science, Boston, and by NASA subject matter experts led by the U.S. Geological Survey Astrogeology Science Center.

PLANETS developed three OST curriculum units and accompanying educator support materials: *Remote Sensing*, *Water in Extreme Environments*, and *Space Hazards*. These units are disseminated nationally through workshops, conferences, and websites. OST educators generously provided feedback on the use of the PLANETS units, on resources they desired to better prepare them to teach, and on how the materials fit within their larger community contexts and OST programs (Haden, 2021).

Ensuring an Inclusive and Equitable Approach to STEM Learning

Upon reflection of educator feedback on the use of PLANETS units, we wondered: Are we doing enough to reach underserved audiences? This question was amplified when an educator at a conference noticed that our logo includes a child in a wheelchair and inquired about the ways in which the PLANETS materials specifically

address these learners’ needs. This was a pivotal moment—we had not yet developed *specific* strategies or resources that *explicitly* address ways that OST educators can reduce barriers to STEM learning for all youth.

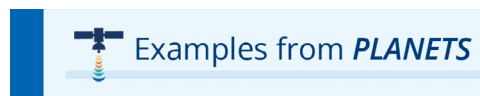
We realized that more needed to be done to ensure the PLANETS program is truly inclusive. We began asking: Who are we really intending to reach? What are effective, research-based strategies for engaging specific audiences? How can we best incorporate what we learn into the PLANETS units for practitioners to engage all youth most effectively?

The promising practices found in this Practical Guide were used to guide the development of the PLANETS curriculum (2025), found here:

<https://planets-stem.org/>

This 2026 edition of the guide includes two new features that illustrate how these promising practices are implemented within the PLANETS curriculum to support inclusion and engagement for all learners.

Examples from PLANETS (shown below): Look for these highlighted call-out boxes throughout the Promising Practices sections. Each example provided demonstrates how a specific promising practice is enacted in the PLANETS units.



Appendices: New appendices provide additional instructional details and unit snapshots that expand on the curriculum examples highlighted throughout the guide.

Figure 1

The PLANETS Guiding Frameworks for Inclusion and Engagement in STEM Learning



Guiding Frameworks

We used the following frameworks to provide an overarching structure for the promising practices shared in this guide: Universal Design for Learning (UDL) and culturally sustaining pedagogies (CSP). These conceptual frameworks were selected based on their foundational ideas and principles to reduce as many barriers as possible in the support for all learners. The four domains of promising practices presented in this guide align with and combine these frameworks to present a holistic approach to engaging learners in OST STEM.

UNIVERSAL
DESIGN for
LEARNING



Universal Design for Learning

Universal Design for Learning (UDL) is an approach for designing learning environments that are accessible, inclusive, equitable, and engaging for all learners. UDL aims to support all learners' agency by changing the design of the environment rather than viewing learner variability as a deficit within the learner.

The UDL approach requires two fundamental shifts in designing learning experiences. The first is to intentionally plan for learner variability, including learners' strengths, needs, interests, identities, and cultural backgrounds. The second is to proactively identify and reduce barriers to learning, including physical, social, cognitive, institutional, and systemic barriers, in order to create accessible and equitable opportunities for all learners.

In using this framework to structure the promising practices that are presented in this guide, we acknowledge that it is not possible for educators to understand all the idiosyncrasies that may arise for different learners, which is

why it is essential to have collaborators, such as family members, cultural liaisons, and interpreters, engaged in the work.

The [Center for Applied Special Technology \(CAST\)](#), a nonprofit research and development organization, developed the UDL framework and organized it according to the three principles of UDL: *multiple means of engagement*, *multiple means of representation*, and *multiple means of action and expression* (CAST, 2024). The recommendations shared in this guide are presented through these three design principles, which are explained below.

Multiple Means of Engagement

This UDL principle for designing learning experiences acknowledges that learners differ in how they are engaged or motivated based on their physical and emotional needs as well as their cultural and linguistic backgrounds. Offering multiple means of engagement gives learners different pathways to motivate them to engage in a learning experience. For example, educators can

provide learners with choice on topics and activities that incorporate learners' identities and backgrounds.

Multiple Means of Representation

This UDL principle acknowledges that learners differ in the ways that they receive and process information. There is not just one optimal means of representation, so providing options is a prerequisite for ensuring access to all learners (CAST, 2024). For example, educators can provide learners with multiple ways to engage with materials such as audio, written text, and 3D models.

Multiple Means of Action and Expression

This UDL principle acknowledges that learners differ in the ways that they can express what they know and communicate with others. Similar to the other principles of UDL, there are numerous means of action or expression. Thus, providing multiple options for action is essential for the inclusion of all learners. For example, educators can provide learners with a choice of how to express their understanding of an activity such as drawing, making video recordings, writing text, or creating models.

Culturally Sustaining Pedagogy

CSP is an asset-based methodology that affirms and supports learners' cultural and linguistic assets while simultaneously offering access to cultural competence throughout all aspects of learning (Ladson-Billings, 1992; Paris, 2012). The tenets of CSP include having high expectations for all learners, having cultural competence to help learners form positive identities, placing learners at the center of learning, sustaining language, and leveraging learners' cultural backgrounds (Snyder & Fenner, 2021; Paris, 2012).

CSP emphasizes focusing on what the learner brings and on how learning can connect to cultural experiences that foster cultural pluralism (Paris, 2012). Celebrating diversity in these ways reflects an asset-based approach. This sort of approach requires noticing and centering the abilities and knowledge that learners have rather than focusing on the challenges that they face and the things they cannot do. In contrast, using a deficit-based approach, which focuses on the challenges that learners face, can result in educators blaming learners or their families for their perceived lack of success (Snyder & Fenner, 2021). The fundamental concepts of respecting and incorporating diverse learners' perspectives into teaching are central to CSP.

CULTURALLY
SUSTAINING
PEDAGOGY



Reaching Diverse Youth

To make sense of the promising practices in this guide, it is helpful to know more about the youth audiences who are the focus of our efforts: Indigenous learners, multilingual learners, and youth experiencing differing physical and/or sensory abilities. While this section describes these youth audiences categorically, we recognize that learners may bring a number of identities and an intersectionality of experiences to a learning setting.

Indigenous Learners

Indigenous learners is the term used in this guide to describe youth who descend from the original, culturally distinct ethnic peoples of a land. While we acknowledge that Indigenous peoples prefer to be identified by their own names and Tribal affiliations, we have opted to use the collective term *Indigenous* for this guide. In the United States, Indigenous peoples are also referred to as Native Americans or American Indians. However, none of these terms originated in the people's distinctive communities. By using the term *Indigenous*, we are not intending to impose a homogeneity. We recognize that Indigenous youth are all unique learners, and their experiences are as diverse as their cultural backgrounds.

It is important to note that the vast majority of current curricula and assessments do not reflect the learning frameworks and worldviews

of Indigenous learners (Barnhardt & Oscar Kawagley, 2005; Chávez & Longerbeam, 2016). STEM learning in the United States has historically been taught within a Western philosophical framework, creating an academic and cultural paradox for Indigenous learners (e.g., Barnhardt & Oscar Kawagley, 2005; Foster & Jordan, 2014; Medin & Bang, 2014). There are consequences to curricula that primarily or completely center Western values and knowledge. Indigenous learners often separate their Western-centric education from their home lives, and they may feel like “guests” in Western educational settings (Allen & Crawley, 1998; Ricci & Riggs, 2019). While differences between Indigenous and Western worldviews do not necessarily prevent Indigenous students from understanding the content, these differences can prevent them from reaching their fullest potential.

While the primary authors of this guide do not identify as Indigenous, in developing this guide we have relied on research about Indigenous learners and on the perspectives and input of OST educators and advisors who identify as Indigenous or have experience with Indigenous learners.

Multilingual Learners

Multilingual learners is the term used in this guide to describe youth who speak languages other than English at home and are in the process of

becoming fluent speakers of English. Following the recommendations of García (2009) and González-Howard and Suárez (2021), we have chosen not to use the term *English language learners* and instead to use terminology that places learners on a spectrum of multilingualism and that does not implicitly limit learners to learning only English. We chose to use the term *multilingual* rather than *bilingual* to create space for learners who speak multiple languages or dialects and avoid reducing their ability to only two languages.

It is crucial to note that this group of learners is extremely diverse—other than being in the process of learning English for the first time, there are no specific traits that all multilingual learners necessarily have in common. Even strictly within the realm of language learning, there is a wide range of proficiency levels, and learners at different points on the spectrum of English ability require different supports to succeed. Outside of language, multilingual learners have all the diversity that is inherent to any population of learners, spanning different geographic locations, disability statuses, gender identities, and sexual orientations, among many other characteristics (González-Howard & Suárez, 2021). They also face a wide variety of challenges that are closely intertwined with their multilingualism. Educators need to get to know their learners as individuals and cannot assume that all multilingual learners have the same needs (Maxwell-Jolly, 2011).

While one of the primary authors of this study is bilingual, in developing this guide, we have relied on researchers and OST educators and advisors who are multilingual or have experience and expertise in multilingual education.

Learners Experiencing Differing Physical and/or Sensory Abilities

In describing learners who experience diverse abilities, it is important to acknowledge that there is not a single definition to encompass *disability* and *people with disabilities*. The term *physical disability* refers to “acute or chronic limitations of bodily function resulting from impairment to an organ (e.g., brain injury) or bodily system (e.g., vision)” (Dunn, Uswatte, Elliott, Lastres, & Beard, 2013, p. 427). Traditional medical models often characterize disabilities as a deficit or “personal tragedy” (Oliver & Barnes, 2012). We advocate for adopting a social model of disability, as described in the literature of the past two decades (Buntinx, 2013). That is, some people experience differing abilities as a result of an environment that is exclusively designed for individuals who are characterized as “normal” (Barnes, 2016; Gill, 1999). The term *diversability* refers to the understanding that every human, disabled or nondisabled, is unique and has potential. It refers to physical, cognitive, developmental, learning and/or neurological differences—or diversity—in ability levels (Langtree, 2025).

It is important for educators to be aware of “invisible disabilities” (e.g., mental health, autism, diabetes) that may affect how learners are able to participate in OST programs (Solomon, 2020), although they are not addressed in this guide.

This guide focuses on youth who experience differing physical abilities: (a) physical traits that affect mobility and/or dexterity; (b) sensory abilities that affect sight; and (c) sensory abilities that affect hearing.

Individuals experiencing *physical traits that affect mobility or dexterity* may have ongoing and changing symptoms that are specific to their impairments. Individuals with dexterity/motor disabilities may experience limited use of their hands, which may range from fine motor skills to digit-specific issues (e.g., missing fingers, polydactyly) to the complete inability to use the hands (Moon et al., 2012). Barriers in STEM for youth experiencing differing physical abilities often involve not having physical access to materials or equipment, either because of lack of accommodations or because of not being included in learning processes with other learners.

Blind or low vision (BLV) learners experience a range of vision issues from total blindness to sightedness beyond what is correctable with glasses (Moon et al., 2012). BLV learners often have the same range of cognitive abilities as other sighted youth and,

with accommodations, can understand high-order science concepts (Jones et al., 2006). BLV learners have been found to be less ready for science classes, which frequently include image-based learning objects (Darrah, 2013; Kolitsky, 2014). Scientific representations pose a primary barrier in learning science, as they often do not convey meaning to BLV learners who have not formed mental images linked to concepts (Jones et al., 2006; Landau et al., 2004), and information contained in a single diagram may require several tactile graphics and verbal descriptions to be understood (Kizilaslan et al., 2021). Other learners may experience color vision issues that also impact their abilities to differentiate visual data.

The *Deaf or Hard-of-Hearing (DHH)* community is diverse, culturally vibrant, and unique—including linguistically, with sign language as the primary language used. Individuals who identify with Deaf culture have deep connections within the community; rely on technology to overcome communication barriers; maintain cultural traditions through social activities; and promote Deaf culture through art forms such as painting, drawing, film, literature, storytelling, and poetry (Barnes, 2016; National Deaf Center on Postsecondary Outcomes, 2019). Learners who are deaf may have little or no speech and often communicate through a sign language interpreter, such as an American Sign Language (ASL) interpreter.

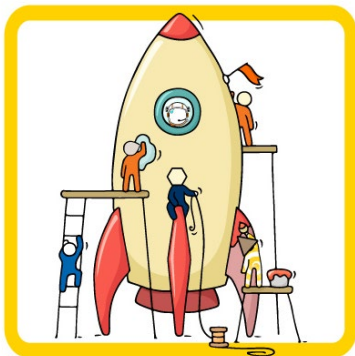
DHH learners may utilize sensory devices (e.g., hearing aids, cochlear implants) and assistive listening devices (e.g., FM systems, sound field systems) to optimize auditory reception of sounds (TTAC Online, 2022).

It may be worth noting to educators that by high school there can be a significant difference in levels of science knowledge between DHH learners and their hearing counterparts. This may occur in part because of (a) limited

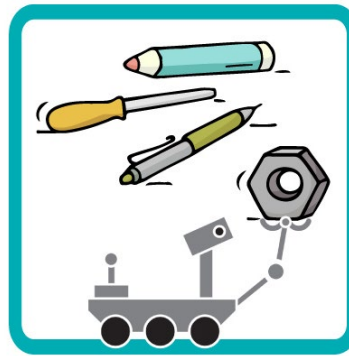
exposure to information in the sciences, (b) lack of understanding of the vocabulary used in science, (c) difficulty for DHH learners to use vision for both watching communication and attending to other learning materials, and (d) a tendency for DHH interpreters to simplify scientific terms and explanations (Spencer & Marschark, 2010). To illustrate the latter point, 60 percent of science-related words deemed essential in a science curriculum review did not have sign vocabulary (Lang et al., 2007).

Promising Practices for Inclusion and Engagement

PROGRAM
DESIGN



INSTRUCTIONAL
PRACTICES

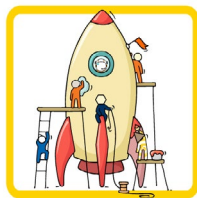


CURRICULUM
DESIGN



PROFESSIONAL
LEARNING



PROGRAM
DESIGN

Promising Practices for Program Design

This section provides promising practices for designing OST STEM programs that foster inclusive, accessible, and engaging learning environments. These practices will likely be of most interest to OST program directors and curriculum developers.

1. Create safe, accessible, and welcoming learning environments
2. Build community and engage families and other supportive adults

“Sometimes [diverse ability] learners have fear—fear of the unknown—especially if it’s outside. If you would have asked me when I became paralyzed, let’s do something recreational. I would have said absolutely not. What if I fall? What is the ground like? What if my chair gets stuck? What if I can’t get in the door? What if I can’t get to the bathroom?”

– OST Educator

1. Create safe, accessible, and welcoming learning environments

Safe learning environments

OST environments can provide a low-stress environment for all learners. When a learning environment is designed to mitigate potential threats, learners can concentrate on their learning instead of focusing on having their basic needs met or protecting themselves from negative experiences (CAST, 2024). All learners need a safe and welcoming environment. For illustration with the intended learners in this guide, multilingual learners need to find their learning environment socially safe to experiment with language, learners with differing

physical and sensory abilities need to feel safe in rich learning environments, and Indigenous youth need to feel valued and safe to share their cultural experiences and knowledge.

Accessible learning spaces

Physical learning spaces and tools for learning experiences need to be checked and reviewed to ensure that they are accessible for all learners. No two learners with similar or differing abilities are the same, and educators need to be prepared to ask learners and caregivers about their needs and respond to their different needs with conversation before and during activities (Table 1 provides a list of recommendations).

Table 1. Recommendations and Accommodations to Create Accessible Learning Environments

Access checkpoints	Be prepared to offer accommodations
Before learners start their programs, educators should be prompted to ask learners and their families/ caregivers about their strengths/contributions and needs (physical and other).	▪ Ensure learning spaces, especially tables or desks, if available, are big enough for a wheelchair to maneuver comfortably. ▪ Provide visual resources (e.g., charts, graphs, posters, whiteboard) at an appropriate height and angle that minimizes strain on a learner with differing physical abilities. ▪ Provide visual schedules, activity outlines, or agenda checklists.
During the learning experience, educators should be prompted to add frequent check-ins with learners and their communities of supportive adults about the activities and to coach learners to self-advocate. Educators should let learners know they are available to assist if they need it. Incorporate "safe" ways for youth to communicate that they need help. This could be as a bright sticky note placed on the desk or a small token left out so that it can grab the educator's attention for guidance, but not in an overt manner.	▪ When having a conversation with a learner who uses a wheelchair or scooter, if possible, educators should sit or crouch down so that they are at eye level in front of them. ▪ Use textured mats under worksheets and manipulatives to stabilize work areas. ▪ Provide paper stabilizers (e.g., clipboards) and use adaptive equipment for posture (e.g., booster seats, armrests). ▪ Provide large and durable materials. ▪ Utilize single-action levers rather than knob controls, and choose materials that are easy to grip. ▪ Provide adapted paper (e.g., bold line, raised line, enlarged spacing). ▪ Use large pencils and/or pencil grips/weighted pencils, and provide a bookstand for books and assignment pages. ▪ Position instructors' stations away from the light that might impede learners' ability to read their instructors' lips. ▪ Frequently review expectations. ▪ Record directions. ▪ Provide visual schedules, activity outlines, or agenda checklists. ▪ Model self-advocacy with structured sentences, such as "I realized I am confused about _____. You mentioned _____; how do you know when to _____?"

Sources: Kohnke, 2022; Moon et al., 2012; Johnson et al., 2014; Fетters et al., 2003; Runyon et al., 2008; TTAC Online, 2022; Melber & Brown, 2008; Martin, 2018.

Welcoming learning environments

Learning environments should be designed to be welcoming in a variety of ways, including culturally and linguistically welcoming. Engaged communication does not need to be only in English, and it does not need to include only one language (McVee et al., 2017). Studies show that multilingual learners benefit from the use of instruction in their primary language (Maxwell-Jolly, 2011). Including multilingual materials does not prevent learners from learning English, and, in fact, it can help them acquire both content knowledge and English proficiency by making some aspects of instruction more accessible (Maxwell-Jolly, 2011). Educators need to be respectful of their learners' languages, particularly of how their languages are presented in relation to English text.

The language and repertoire used by learners to express themselves should also be valued. Spycher and Haynes (2019, p. 221) share how multilingual learners were well-supported in a science unit on garbage:

Students made observations of the mound of garbage using everyday language (e.g., students say, "It smells like _____ when the garbage truck drives by my house!") and home language (e.g., students say, "¡Qué asco!"). Importantly, their observations are valued for their contribution to the discourse, not their linguistic accuracy. Students also use multiple modalities, including drawings, symbols, and text, to develop initial models of smell. Over the course of

the unit, as students develop deeper understanding of science to make sense of the phenomenon of garbage, they adopt a more specialized register (e.g., students say, "Smell is a gas made of particles too small to see.") and use modalities more strategically (e.g., students use arrows to represent gas particles moving freely in space) to communicate the sophistication of their ideas.

To create safe, accessible, and welcoming learning environments, educators can do groundwork in their communities to gain deep knowledge of the learners' contexts, spend time in and be seen in their communities, and allow community members to become familiar with them. It is also helpful to identify key community members and other educators who can serve as cultural informants/liaisons and are able to support educators to learn to recognize local communication styles, such as who speaks to whom about what topics under what circumstances.

"It's really important to let families know that they are welcome and that this space belongs to them too. Parents want to feel part of that community, so you really need to build those relationships with the parents."

– OST Educator

2. Build community and engage families and other supportive adults

Building community within OST programs offers numerous benefits and was emphasized by many OST educators in this study. Building community encompasses having ongoing and meaningful two-way interactions between educators and families and/or other communities of supportive adults (Snyder & Fenner, 2021) and creating a learning environment within OST programs that is familial, supportive, and empowering (Afterschool Alliance, 2011). OSTs with strong learning environments and communities recognize the assets that youth bring and allow youth to express themselves, making them feel comfortable engaging in STEM content (Ricci & Riggs, 2019).

Table 2 lists strategies to further engage communities of supportive adults influencing the lives of youth.

To engage all learners and their influencing communities, educators must (a) recognize the need to use a variety of communication methods and (b) acknowledge challenges to family and community engagement, and they must address such challenges when possible. Educators can actively invite families and community members to engage in STEM learning, collaborate in teaching, and contribute to curricula building (Massachusetts Department of Elementary and Secondary Education, 2020).



Examples from *PLANETS*

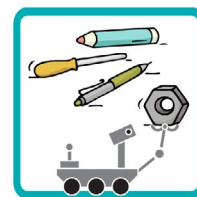
Features of Accessible and Welcoming Learning Environments

- **Accessibility Checks** — accessibility checks encourage all learners to share their needs to fully participate and feel comfortable in an activity or space. It can be anything that helps you learn, communicate, move around, or just feel safe and included.
- **Family Connections Invitations** — families and caregivers are sent a flyer offering multiple entry points from low-barrier at-home storytelling prompts to active program participation to meet diverse schedules, comfort levels, and participation preferences.

See [Appendix A](#) to learn more about examples in the *PLANETS* units.

Table 2. Strategies and Practices to Engage All Learners and Their Families/Communities of Supportive Adults in STEM Learning

Overarching strategy	Suggested practices
Use a variety of communication methods	▪ Provide printed materials in families’ home languages. ▪ Engage with families during high-leverage times such as during pickups and drop-offs and know that building trust takes time. ▪ Programs should evaluate whether all families have access to information that is easily understandable as well as a way of letting the program know if the information is not accessible. ▪ When hiring staff, look for representation and diversity that fits the needs of the learners’ populations.
Acknowledge challenges to family and community engagement	▪ Educators should approach all families with the assumption that they are engaged and invested in their children’s learning. ▪ Be aware of possible barriers families might face, such as language barriers, lack of transportation or time, lack of understanding of the school system, and fear of engagement. ▪ Know that family engagement may take different forms than educators are trained to expect. ▪ Be flexible with families. ▪ Welcome family engagement and involvement, but do not require it. ▪ Be accessible and use local and culturally appropriate ways of interacting with families.
Invite families to engage in and design STEM learning activities	▪ Invite family members to share about themselves, including sharing stories or sharing about their professions, lived experiences, and the ways they use STEM principles in their work and daily lives. ▪ Share activities for youth to do with their families at home. Connect these activities to the needs and interests of families (e.g., food security, safety, construction). ▪ Invite community members to contribute to the curriculum by asking them to provide ideas of important science topics for their children to learn. ▪ Ask for family volunteers to come into the OST site to help and be engaged in lessons (and sometimes to lead specific lessons themselves as a special guest). ▪ Ask for input on the rules and values practiced in OST programs. Know that some types of activities are prohibited in some cultures—it is important to be clear about these in advance. Understand parallel beliefs around animate and inanimate objects.



Promising Instructional Practices

This section provides promising instructional practices that support OST educators in facilitating inclusive, engaging, and learner-centered STEM experiences for all learners. These practices will likely be of most interest to OST educators.

1. Facilitate inclusive and cooperative learning environments
2. Build relationships for learning partnerships
3. Encourage translanguaging and storytelling

“I’ve seen cases where I’ve come across groups [of kids] where they already know how they’re going to support their classmates. They’re ready and say, ‘I’m going to read this out to you.’ And I’m like, awesome, she is doing that. ...That’s when kids’ resilience pops up, and I’m always amazed by that. For the most part, kids can make friends with anybody, [which] is just one of those amazing qualities about them.”

– OST Educator

1. Facilitate inclusive and cooperative learning environments

OST programs have flexibility to create affirming, inclusive, and cooperative learning environments. The UDL design principle of providing multiple means of engagement stresses offering options to sustain learners’ efforts and persistence on tasks. This promising practice applies to all of this guide’s intended learners and requires planning from OST educators.

When working with learners who experience differing physical and/or sensory abilities, in particular, the OST educators indicated that they find it helpful to be proactive in communication. They shared that while the majority of learners know how to work with other learners who are different than they are, some may also be unsure about how to be flexible or patient with others. This flexibility and patience both start with learning about different learners’ respective strengths and limitations.

For some learners, this does not come naturally, and educators need to provide them with encouragement and adequate opportunities to practice. Table 3 outlines further strategies for facilitating an inclusive and cooperative learning environment before and during learning experiences.

“I always have students seated in groups so that they can see what the item looks like in different iterations. It’s a combination of individual and group input and then [a] larger group.”

– OST Educator

Asset-based approach

To create an inclusive learning environment, educators need to approach their learners with an asset-based mindset. Each individual possesses assets that contribute to the development and maintenance of that person’s identity. Assets can be intellectual, physical, social, or professional skills; personal strengths or qualities; social support; goals; material goods; sense of humor; and tenacity (Dunn, 2010; Dunn et al., 2009). For learners experiencing differing physical and sensory abilities, a strengths-based approach cannot ignore individuals’ limitations or

impairments but should amplify the individual’s agency by identifying and building on their functional strengths (Buntinx, 2013). No physical disability can eliminate all of one’s assets or chances to develop new assets.

Snyder and Fenner (2021) define an asset-based mindset with respect to multilingual learners as a “perspective [that] values learners’ home languages and cultures and sees these gifts as foundations for future learning rather than as obstacles or even hindrances to overcome” (p. 77).

In general, an asset-based approach requires noticing and centering the abilities and knowledge that learners have rather than focusing on the challenges that face them and the things they cannot do. Using a deficit-based approach, which focuses on the challenges, can result in educators blaming youth or their families for their perceived lack of success (Snyder & Fenner, 2021).

An asset-based mindset is a crucial component of culturally sustaining education since it allows educators to focus on what learners know and what their cultures contribute rather than focusing on the “problem” of their home culture’s difference from mainstream American culture. Deliberately approaching learners from an asset-based perspective helps educators mitigate biases and embrace a wide variety of ways of thinking.

Table 3. Sample Process for Facilitating Inclusive and Cooperative Learning Environments

Stage of setting up learning environment	Suggested practices
Beginning OST learning experiences	▪ Ask learners to share what they need. ▪ Clarify fairness and equity in the learning environment—some learners may need extra help. ▪ Acknowledge with learners that educators do not know everything, and establish ways for learners to find out what they need to know and who to go to for additional help. ▪ Help youth learn when to help and when not to help peers. ▪ Help youth learn about one another’s strengths and challenges/limitations.
Setting up tasks for OST learning experiences	▪ Be intentional about forming groups that include multiple roles. Group work should be designed so that all members can contribute with an equitable and valued status (Arbour-Nicitopoulos et al., 2018; Gilles et al., 2019). ▪ Assign youth specific group roles that are considerate of their abilities and areas for growth and that focus on a common goal (Arbour-Nicitopoulos et al., 2018; Villanueva & Di Stefano, 2017). For example, ensure all learners have opportunities for the full range of group roles, from leadership and facilitation to note-taking and research, based on their interests and strengths rather than assumptions about their capabilities. When necessary, provide appropriate supports (such as assistive technology for note-taking or visual materials in accessible formats) to enable genuine learner choice across a wide range of roles. ▪ Encourage different ways for group members to interact with one another. For example, where appropriate, utilize technology such as Google Translate forums to ensure that communication between learners is accessible and inclusive (Burgstahler, 2020), or utilize members of the community who speak the same language.
During OST experiences	▪ Be purposeful about seating arrangements to welcome cooperative learning. Allow and encourage learners to experience iterations of projects. ▪ Be mindful about not praising behaviors that undermine the abilities of learners experiencing diverse abilities (e.g., having a youth be called a “helper” for pushing another youth’s wheelchair). Foster collaborative relationships where all learners contribute meaningfully and are held to high expectations.

“During the NASA ROADS program, my students had to keep a drone flying up for 10 seconds. We had our youngest student who was in fourth grade. The fourth-grade student was excited and wanted to try. I was really not sure he was going to do this, and he landed it on a bull’s eye. I try not to put a ceiling on my expectations! This student had a visual impairment. He could hear what he was flying. He had so much experience using toggle. He was listening to where the drone was. ... My advice is to step back when you want to go and help them. It’s amazing. ... Trust that the student can do it.”

– OST Educator

2. Building relationships for learning partnerships

OST educators describe relationship-building as a central component of their work. Research shows that relationship-building can increase learners’ resiliency and support learner growth by providing an environment of reinforcement and constructive feedback for physical, social–emotional, and intellectual growth (Roehlkepartain et al., 2017).

Hammond (2015) identified three core components for building relationships and learning partnerships: (a) building rapport to establish an emotional connection, (b) affirming the personhood of each youth by appreciating all aspects that they bring into a learning space, and (c) validating learners’ experiences and the inequities that they may experience.

As outlined in Table 4, [The Search Institute’s Developmental Relationships Framework](#) (p. 25) identifies five key elements that summarize instructional tips and strategies for building relationships with students that are shared by OST educators.



Example from *PLANETS*

Instructional Practices for Building Relationships

Inclusion activities — a variety of asset-based activities are used across the PLANETS curriculum that explicitly invite learners to share about themselves in ways that honor their personal and cultural contexts, build community, and support learning.

See [Appendix B](#) for how “Story of Your Name” and “Choose an Object,” are used as inclusion activities in the PLANETS units.

3. Encourage translanguaging and storytelling

The languages and cultural practices of youth acquired from their homes and communities, as well as through their formal and informal learning, should be viewed as assets that can enrich all students (García et al., 2017).

Translanguaging

OST educators share that translanguaging and storytelling encourage learners to participate and engage in sensemaking and learning. Translanguaging is a practice in which educators acknowledge the language practices that learners bring, such as understanding multiple languages and code-meshing, to make meaning with others (Martin-Beltrán et al., 2019). Educators can encourage translanguaging through the following:

- Encourage learners to make use of their linguistic assets by using their primary language alongside English in activities.
- Encourage learners to use their primary language in journals or writing or in small groups with others who share that language (Ryu, 2019).
- Model translanguaging for learners (if the OST educator also speaks the primary language of multilingual learners in their class); in conversation with multilingual learners, switch between languages to encourage learners to do so as well (Suárez, 2020).
- Explicitly state that translanguaging is encouraged in the class (while it can be harder to promote translanguaging if the OST educator does not share the non-English languages with their multilingual learners, this encouragement helps learners feel comfortable doing it on their own; Ryu, 2019).
- Be open and willing to learn words from other languages (this shows youth that learning takes time, understanding and communicating with one another is important, and mistakes often happen; Suárez, 2020).
- Use and celebrate the use of sign language to celebrate the linguistic and cultural diversity of learners who are Deaf.



Examples from *PLANETS*

Instructional Practices for Translanguaging and Storytelling

- **Storytelling** — activities that invite learners to share their personal and cultural experiences position them as experts with valuable knowledge—for example, creating art to tell your story, writing a poem, recording on a device, creating a performance, or building something to demonstrate.
- **“Our Ideas” poster** — this visual sensemaking tool is used across multiple PLANETS activities to capture ongoing language development, honoring learners’ home languages and cultural references.

See [Appendix C](#) to learn more about examples in the PLANETS units.

Table 4. Elements and Related Actions for Building Relationships With Students

Elements	Actions	How would this be viewed by students?
Express care <i>“Show me that I matter”</i>	▪ Be dependable ▪ Listen ▪ Believe in me ▪ Be warm ▪ Encourage	▪ Be someone I can trust. ▪ Really pay attention when we are together. ▪ Make me feel known and valued. ▪ Show me you enjoy being with me. ▪ Praise me for my efforts and achievements.
Challenge growth <i>“Push me to keep getting better”</i>	▪ Expect my best ▪ Hold me accountable ▪ Reflect on my failures	▪ Expect me to live up to my potential. ▪ Push me to go further. ▪ Insist I take responsibility for my actions. ▪ Help me learn from mistakes and setbacks.
Provide support <i>“Help me complete tasks and achieve goals”</i>	▪ Navigate ▪ Empower ▪ Advocate ▪ Set boundaries ▪ Check for understanding	▪ Guide me through hard situations and systems. ▪ Build my confidence to take charge of my life. ▪ Defend me when I need you to. ▪ Put limits in place to keep me on track.
Share power <i>“Treat me with respect and give me a say”</i>	▪ Respect me ▪ Include me ▪ Collaborate ▪ Let me lead	▪ Take me seriously and treat me fairly. ▪ Involve me in decisions that affect me. ▪ Work with me to solve problems and reach goals. ▪ Create opportunities for me to take action and lead.
Expand possibilities <i>“Connect me with people and places that broaden my horizon”</i>	▪ Inspire ▪ Broaden horizons ▪ Connect	▪ Inspire me to see possibilities for my future. ▪ Expose me to new ideas, experiences, and places. ▪ Introduce me to more people who can help me grow. ▪ Provide me with representative STEM role models.

Source: Roehlkepartain et al., 2017.

Storytelling

Storytelling is both an input and a medium for learners to process and express their ideas. It is also an important strategy to promote the assets of youth. Storytelling involves holding space for learners to tell stories and for stories to be told to them (Barajas-López & Bang, 2018; Chávez & Longerbeam, 2016; Tzou et al., 2016). OST educators should be aware of cultural appropriation in storytelling, taking stories out of context or telling stories that are culturally inappropriate. For example, for some Indigenous people, stories might only be able to be told during certain times of the year or to youth who have reached a certain age or level of knowledge.

The following strategies can be used to facilitate the general use of storytelling:

- Ask youth to write or talk about their personal narratives.
- Create and conduct short, guided interviews with youth.
- Play storytelling games such as the Story Stitch game, which encourages storytelling using a deck of cards with questions and opportunities to connect players to each other and find shared feelings and experiences.
- Encourage youth to tell stories or explain their thinking through artwork and other methods of creative expression.
- Create learner information cards at the beginning of the program when learning about youth; these cards can highlight their learning styles, strengths, and interests on one

side and, on the other side, learners can include a selfie or an image of themselves. This strategy works with learners who are hesitant or unsure of what to share about themselves.

- Be observant and curious about different storytelling styles.
- Invite visitors to tell stories—for Indigenous learners, storytelling, particularly oral storytelling, done by an Elder or an Indigenous author/educator, can help learners process science concepts from an Indigenous perspective.

“The paramount transformational learning happens when you bring in cultural knowledge keepers or community Elders. You can’t really have them share a story, put it down on paper, and then have someone else read it. [That] doesn’t work and the translation is lost. ... It is important for the teachers to know what’s out there, but also to know who the resources are that can share that knowledge.”

– OST Educator



Promising Curriculum Design Elements

This section provides promising curriculum design elements that support educators in facilitating inclusive, engaging, and accessible STEM learning experiences in OST settings. These practices will likely be of most interest to curriculum designers, program directors, and OST educators.

1. Design learning experiences that are authentic and relevant to the contexts of learners
2. Incorporate multisensory instruction
3. Provide options for multiple forms of expression to demonstrate understanding

“I’ve learned over the years that when I’m particularly working with Native students, if I can connect them to something immediate and do something that matters to them, their family, their community, then they are very interested.”

– OST Educator

1. Design learning experiences that are authentic and relevant to the contexts of learners

When designing engaging learning experiences, it is important to situate STEM in the context of learners’ lives and communities and provide opportunities for learners to use scientific principles to solve problems

in their communities. OST learning provides affordances and flexibility to create space for learning about what is meaningful to youth. It also makes it clear to learners that STEM is useful to them and relevant in their outside lives (Lee & Buxton, 2008; Schenkel et al., 2020). This can happen by giving learners autonomy to explore issues that matter to them.

Example # 1: Connecting the engineering process to learners' lives

When an OST educator interviewed in this study introduced an engineering process to her learners, she solicited their feedback on problems that the engineering process might help them solve. The youth chose to make construction work safer to address work-related injuries that their families experience. Both the youth and their educator found it meaningful to discuss engineering concepts and vocabulary in light of personal contexts for problems and solutions.

Example # 2: Investigating the biodiversity of the local area

Schenkel et al. (2020) describe a unit on stopping the spread of an invasive plant species in which students investigated the biodiversity of their local neighborhoods and the impact of an invasive plant (garlic mustard). Students observed the prevalence of garlic mustard and conducted interviews with community members about its impact on the local ecosystem. Then, students worked together to create a garlic mustard harvesting guide, which they used at school and took home for use in their communities.

“For us, there has to be a cultural piece. Whatever it is, it has to have a lens. So, even if we take something that is Western science, we will talk with cultural knowledge keepers. We will find out what that connection is because there’s always a connection. Seeing a connection is huge for our students. I think that’s why so many students within our program stay in school—because they have that cultural connection, and it keeps them engaged. And now they have a better understanding of how the pieces all fit together.”

– OST Educator

Studies show that the use of a variety of multicultural resources and instructional strategies in learning environments is a critical way to foster a learning environment that recognizes all learners (Ingalls et al., 2006; Snyder & Fenner, 2021). Including links and references to multicultural resources and creating lessons that include the multiple perspectives of a wide range of learners' cultures are also important signposts of curricula that help to foster culturally welcoming learning environments (Fenner & Snyder, 2017). Educators in this study's focus group shared that getting to know their learners' backgrounds is the first key step in creating culturally welcoming learning environments.

A number of OST programs across the United States have begun to

collaborate with Indigenous leaders (whether community members, Elders, educators, or Tribal liaisons) on respectful and impactful ways to begin with and incorporate Indigenous knowledge into curricular activities (Bang et al., 2014; Garcia-Olp et al., 2019; Semken et al., 2017; Tzou et al., 2016). These various programs, whose collaborations range from working with local Indigenous youth centers (Bang et al., 2014) to working with universities serving Indigenous populations (Halford, 2003), have highlighted the success of working directly with Indigenous leaders in engaging Indigenous youth in OST programming.

Intentional connections to place in STEM learning provide opportunities for learners to build on the diverse meanings they've already developed

Example # 3: Two-Eyed Seeing

Educators working with Indigenous youth shared that they anchor their work through the guiding principle of Two-Eyed Seeing, which was introduced by Elder Albert Marshall. "Two-Eyed Seeing refers to learning to see from one eye with the strengths of Indigenous knowledge and ways of knowing, and from the other eye with the strengths of Western knowledge and ways of knowing ... and learning to use both these eyes together, for the benefit of all. Elder Albert indicates that Etuaptmumk—Two-Eyed Seeing is the gift of multiple perspectives treasured by many Aboriginal peoples" (Bartlett et al., 2012, p. 340).

In Two-Eyed Seeing, cultural knowledge keepers are brought in on an equal platform with educators to present learning experiences to learners (Bartlett et al., 2012). By bringing in these cultural knowledge keepers, educators recognize and acknowledge with learners that there are multiple ways of viewing the world that do not necessarily overlap or present as a one-to-one relationship (Berkes, 2017). It is important to acknowledge that Two-Eyed Seeing recognizes the need to work with community members from the conceptualization of the learning to its implementation. These ideas of multicultural perspectives apply to all learners as we encourage broader understanding of perspectives and ways of knowing the world.

through lived experiences with their local environment and communities (Semken et al., 2010; Semken & Freeman, 2008). These connections may strategically surface and use learners' experiences with the physical environment as well as the cultural, historical, familial, and other meanings associated with a place. Learners can deepen their understanding of places through lived experiences such as field trips, collecting and analyzing primary data, stories from elders in the community, or via photography, satellite images, or a virtual reality tool to help them feel as if they are experiencing space (Johnson et al., 2014; Semken et al., 2017). For many Indigenous communities, relationships to particular lands and natural resources are also deeply connected to cultural knowledge, identity, and practice. For example, brown ash trees are highly prized within some Indigenous communities. One OST educator shared their experience designing a learning experience for their learners to investigate ash quality and explore the cultural practices of cutting down the tree and incorporating brown ash to make bookmarks.

2. Incorporate multisensory instruction

“Think of your five senses and think about how you can get whatever you’re thinking about as the topic, or the activity, when

you can hit all five of those senses and you know you’re on the right track.” – OST Educator

A multisensory approach to instruction incorporates visual, auditory, and tactile modalities of learning.

Visual representations can benefit STEM learning for all learners and are particularly beneficial for youth who are DHH, multilingual youth, and Indigenous youth. For example, Indigenous communities following traditional or subsistence lifestyles teach children to be skilled observers. Visual science and engineering models are powerful tools to illustrate observations, processes, and connections. Digital media (e.g., websites, PowerPoints, and e-posters) can be another form for engagement and communication. These modes of representation can be expanded for diverse learners to include video or audio recordings of presentations, written presentation notes, and other forms of artifacts, such as collected library materials (Chávez & Longerbeam, 2016).

While visual representations benefit most learners, there is no single form of representation that is optimal for all learners. Visual representations are inaccessible for learners who are BLV and thus can become critical access barriers.¹

¹ Technical guidelines on providing written visual descriptions for STEM images are described by GBH and can be found at http://ncamftp.wgbh.org/ncam-old-site/experience_learn/educational_media/stemdx/guidelines.html.

Auditory learning

Auditory modalities of instruction can facilitate access to graphic representations, measurements, and texts in science for learners who are BLV (Cryer, 2013). OST educators shared that providing audio recordings of texts and graphical representations both before and after activities can be beneficial for learners who are BLV. The use of talking measuring devices such as scales and thermometers is also helpful (Rosenblum et al., 2019).

These auditory strategies are also supportive of multilingual learners, who benefit from reading texts aloud and lowering the speed of the videos. Read-alouds can also be made to shorten and simplify texts for learners. Subsequently, materials that can be read aloud through available devices for learners are important and should be appropriately formatted to enable a read-aloud.

Tactile learning

Using three-dimensional (3D) tactile models is often cited in the literature and mentioned by OST educators as a way to provide multiple means of representation for STEM learning. Tactile models and the use of realia are beneficial for all learners with varying learning styles but are particularly important for BLV learners. OST educators recommended the following resources to create tactile models for learners:

- [American Printing House](#) for accessibility solutions for science and other subject areas
- [Perkins School for the Blind website](#) for accessible science lessons

OST educators also shared emerging technologies that can convert visual images into tactile models (Childers et al., 2015), such as [TactileDoodle](#), that can create quick 3D tactile graphics for learners.

Designing Curricula With Multisensory STEM Activities

Examples

- Create a kinesthetic system, such as the solar system or a human circulatory system, in a large space, such as the playground.
- Use electric circuits with noise-generating motors instead of light bulbs.
- Use tactile syringes to explore air movement.
- Use a beeping meter for a gas-sensing activity.



Example from *PLANETS*

Designing Curricula With Multisensory STEM Activities

- Create tactile models by adding glue or paint lines to data lines, axes, and visible spectrum boundaries on spectroscopy graphs.

See [Appendix D](#) to learn more about this example in the *PLANETS* units.

“I modified our activity to represent the life cycle of a jellyfish. In doing so, I had to find a tactile way to model that—so I had a Dixie cup, and we would cut it a certain way to make it look like a Medusa. Then, we talked about the polyp, but it was a different shape. It made a difference just having something tangible to really feel.”

– OST Educator

3. Provide options for multiple forms of expression to demonstrate understanding

Inclusive curriculum design ensures that learning activities provide multiple entry points for learners to express, communicate, and demonstrate their understanding of learning activities. Providing multiple options for expression helps create learning environments that are cognitively and socially inclusive.

Multilingual learners and learners who are DHH may benefit from nonlinguistic modes of communication and expression, such as physical demonstrations, drawn images or diagrams, and the creation of models using clay or other building materials. Linguistic modes of communication can

also support multilingual learners and learners who are BLV. These linguistic modes of communication can include providing sentence starters; assigning learners scribes; using Chromebooks with low-vision accessibility features that provide accommodations to support reading and writing, word banks, and graphic organizers; and expressing understanding through songs, chants, and skits. Refer to Table 5 for more linguistic and nonlinguistic ideas.

Assistive technologies can augment and provide alternative communication methods to improve daily communication and language skills for learners. Assistive technologies also play an important role in supporting social inclusion by providing multiple ways for learners to engage in meaningful discourse with others in informal STEM learning (Lemke, 2001).

Table 5. Nonlinguistic and Linguistic Modes of Communication

Nonlinguistic modes of communication	Linguistic modes of communication
▪ Providing physical demonstrations ▪ Drawing ▪ Creating art and models using clay or other building materials ▪ Using images, photos, and video ▪ Using exemplars to showcase to learners ▪ Using gestures ▪ Creating physical devices and using technologies	▪ Providing sentence starters ▪ Assigning scribes ▪ Using Chromebooks with accommodations such as dictation and text-to-speech features to support reading and writing ▪ Using word banks ▪ Using graphic organizers and notebooks ▪ Writing guidelines and outlines ▪ Facilitating discussions at varying levels ▪ Encouraging expression through songs, chants, and skits

Curriculum Design Features Suggested by OST Educators

- Multilingual resources made available, including parent newsletters, worksheets, summary sheets for parents
- Affordable and durable materials that can be used more than once
- Resources that provide learners with multiple methods of expression, including sentence starters, word banks and graphic organizers
- Multiple examples of the types of products youth might design or create to help provide mental models
- Resources that provide multiple points of engagement, including short videos, stories, visuals, and real objects
- Embedded accommodations throughout the learning activities:
 - » simplified texts
 - » read-alouds
 - » shortened videos
- Precut materials
- Larger materials for learners with challenged fine motor skills
- Resources for learners with missing limb(s)
- Quick CliffsNotes on science content
- Resources that provide educators with tip sheets and examples on how to foster community partnerships
- Blueprints for 3D printing of tactile materials



Promising Practices for Professional Learning

This section provides promising practices for designing professional learning that supports OST educators in implementing inclusive, engaging, and accessible STEM learning experiences for all learners. These practices will likely be of most interest to professional learning developers and OST educators.

1. Develop educators' cultural literacy and their knowledge and awareness of youth and their communities
2. Provide opportunities for educators to reflect on their own backgrounds and assets
3. Offer immersive and low-risk professional learning

One especially key message emerged from both the literature in the field and OST educators interviewed in this study: In order for youth to have access to the inclusive and engaging STEM learning opportunities they deserve, we need to invest in the educators themselves. This includes offering high-quality professional learning that allows for multiple means of engagement through a variety of formats and a range of delivery options (Clark et al., 2021).

More specifically, professional learning could offer immersive experiences that bring together OST educators with youth who have different physical and/or sensory abilities. It could also mean providing a risk-free space for educators to reflect on their own backgrounds and assets, along with offering resources that help educators develop deeper cultural knowledge and awareness of the youth they teach and the communities in which they teach them. Other examples of high-quality

professional learning include lesson studies, hands-on learning experiences, and opportunities for coaching. Educators interviewed in a study by Clark et al. (2021) shared the need for both synchronous and asynchronous professional learning opportunities.

“I prefer hands-on professional development, having internships to work with students who have disabilities. Those students are great about giving feedback themselves. In fact, they give the best feedback.”

– OST Educator

OST educators in this study also asked for asynchronous learning support, such as videos that highlight adjustments to activities, brief descriptions of adaptations,

descriptions of child development milestones, and one-page summaries on child safety and activities that support building a rapport with families.

While investing in professional learning is important, it requires significant time and expenses that can be challenging for both OST educators and OST programs (Yohalem & Wilson-Ahlstrom, 2010). This section offers some targeted recommendations for OST program administrators and professional learning developers to consider when designing and choosing professional learning opportunities for their educators.

1. Develop educators' cultural literacy and their knowledge and awareness of youth and their communities

One essential element in working with diverse learners is to focus on promoting cultural literacy. Educators can benefit from professional learning that provides opportunities to explore how to build cultural literacy. Promoting cultural literacy may be challenging when providing support to educators working with learners who have a variety of cultural backgrounds in their OST settings. In these circumstances, introducing a “Get to Know You” type of activity to use with youth and their families can support educators in building students' awareness of family and community cultural backgrounds. In cases in which

the OST educator is working with youth from a relatively homogenous cultural background other than the educator's own background, it is important for the educator to learn about that culture. For example, specific educators working with Indigenous youth could be supported to learn about general Indigenous histories, worldviews, and values (Ingalls et al., 2006; Pewewardy & Hammer, 2003) and the specific history, worldview, and values of the nation whose land is hosting the OST programming. Professional learning supports can incorporate the voices of Indigenous community members and can include suggested lists of videos, readings, and works by Indigenous creators.

To enable educators to support youth experiencing differing physical and/or sensory abilities, professional learning should promote an understanding of social and cultural models youth experiencing differing (physical) abilities and their communities. An increased understanding of particular social models promotes the understanding that learning environments have typically been designed for individuals characterized as “normal,” which can limit the inclusion of those who are perceived to be outside of this norm (Barnes, 2016; Gill, 1999). In addition, educators should increase their awareness of how some imposed normative standards affect and exclude learners (e.g., language that does not reflect inclusivity). This helps them become more attuned

to identifying and removing social and cultural barriers (Barnes, 2016). This learning is best accomplished by engaging individuals who experience different abilities to lead awareness sessions.

Overall, professional learning for OST educators can promote the expansion of knowledge and communication about the needs of the intended youth in important ways, including the following:

- raising awareness of the developmental and contextual needs of youth
- ensuring relevancy of OST curricula to youth and their communities
- pointing out the potential barriers faced by youth in less inclusive learning environments
- identifying the rights and responsibilities of youth and OST educators
- pointing out strategies to engage parents from different backgrounds and strategies to build relationships
- identifying local organizations and mentors who can support the bridge between programs and the needs of youth and their families

2. Provide opportunities for educators to reflect on their own backgrounds and assets

To develop culturally sustaining practitioners, OST educators need to understand their own cultural reference

points, cultivate self-management skills to grow in cultural intelligence, and learn to expand their interpretations of youth behavior to include different cultural displays of learning and social interaction (Snyder & Fenner, 2021).

The “invitations to inquiry” listed in Table 6 are recommended by Hammond (2015) and others to prompt OST educators to reflect on their cultural references and biases to cultivate cultural competency.

For OST educators working with youth experiencing differing physical abilities, educators can be invited to reflect on their own underlying assumptions toward varying abilities to help them realize that some of these perspectives may be interfering with providing an inclusive learning environment.

Nevin et al. (2008) propose questions to shift educators’ focus away from a needs- or deficit-based approach that focuses on “helping” individuals cope with “disabilities” to a more empowering person-centered, strengths-based orientation that is grounded in the perceptions of individuals being competent and thriving. Table 7 lists strengths-based questions.



Examples from *PLANETS*

Educator Instructional Supports

Concise tips and videos are provided for teachers within each activity that highlight learner differences to be mindful of and offer instructional strategies to support learners’ engagement and inclusion.

See [Appendix E](#) to learn more about educator supports in the *PLANETS* units.

Table 6. “Invitations to Inquiry” That Help Foster Cultural Intelligence

Invitation to inquiry	Prompts and questions to ask
What are your current cultural frames of reference?	▪ How would you describe what it means to be a cultural being? ▪ What are your cultural assets? ▪ What/who has helped you achieve your successes? ▪ Where do you go for support? ▪ What led you to become an OST educator? ▪ What/who helps you grow and learn? ▪ What is your cultural history? ▪ What stories are a part of your culture? ▪ How might your cultural frame bias your instruction?
What processes have you engaged in to examine your shallow and deep cultural beliefs?	▪ What values do you hold about the meaning of self-motivation and effort? ▪ How were you expected to interact with authority figures? Was the authority of teachers and other elders assumed, or did it have to be earned? ▪ List all the learning behaviors that you believe every youth should exhibit, such as collaboration, seat time, interaction time, and volume of interaction. ▪ Are your identified learning behaviors inclusive of all learners? Where and when do you need to be flexible?
What youth social and learning behaviors cause you stress in the learning environment?	▪ Explain the behaviors or attributes of certain learners that trigger you. ▪ Do you acknowledge learner behaviors as a form of communication?
What biases or assumptions might be behind your stressors?	▪ Reflect on your assumptions and why you find certain behaviors problematic. Examples include assuming that certain bodies and minds are “normal” and others are not, being aligned with cultural norms, and following certain communication rules. ▪ List alternative explanations or interpretations of the behaviors that you find problematic. ▪ Discuss these alternative explanations or assumptions with a colleague, parent, or community member.
How do you manage your emotional intelligence in cross-cultural interactions?	▪ Identify what causes emotional stress while teaching. ▪ Label your feelings when they come up. ▪ Create an early warning system. ▪ Brainstorm on how to change the activities or learning environment. ▪ Broaden your body of explanations and interpretations of learner interactions.

Source: Dray & Wisneski, 2011, Smith et al., 2021, and Hammond, 2015. Hammond compares the term *trigger* to a smoke detector. In this analogy, our brains are wired with smoke detectors that look for behaviors that might cause us social embarrassment or emotional pain. When confronted with these triggering behaviors, our brains become culturally “reactive” rather than culturally responsive (p.64). Behavioral and learning triggers include disrespect, talking across the learning space, and lack of eye contact.

Table 7. Questions for Shifting Educators Toward a Strengths-Based Perspective

Perspective	Useful questions to pose
Show interest	What does the learner think, feel, and want?
Show appreciation	- What is great about the learner's life? - What are their aspirations, joys, and dreams?
Be curious	- How can I be of service to this learner? - How can I go on a path with this learner?
Reveal reciprocal and collaborative expectations	- How can/will I collaborate with this learner? - How can both our lives be enriched by this relationship?

Source: Nevin et al., 2008.

3. Offer immersive and low-risk professional learning

Immersive professional learning experiences provide educators with low-risk opportunities to work directly with youth, including engaging in hands-on activities with different learners. This allows educators to practice knowledge and skills acquired in a professional learning session. Explicit guidance on instructional adjustments and etiquette can be made during these experiences.

For educators working with youth experiencing differing abilities, studies have shown that personal experiences with individuals who experience differing abilities combined with knowledge acquired from professional learning are more likely to change practice than is either of these elements alone (Sharp et al., 2012). OST educators shared similar recommendations that immersive experiences and interactions with youth during professional learning have been shown to be effective in shifting attitudes toward youth.

Example of an Immersive Professional Learning Program for Science Educators

A National Science Foundation-funded professional development program, Creating Laboratory Access for Science Students (CLASS), included instruction and practice in the use of assistive technology. Researchers found that the most important element of the professional learning model was providing educators with experiences in a risk-free environment with learners who themselves experience differing physical and/or sensory abilities (Bargerhuff et al., 2010).

For educators working with Indigenous youth, Chinn et al. (2014) found that professional learning resources that integrate Indigenous and Western values and knowledge are especially helpful for educators, particularly for non-Indigenous educators. It is important to build non-Indigenous educators' interest and confidence in teaching culturally relevant curricula using culturally sustaining pedagogies (Chinn, 2015). If possible, professional learning experiences should be synchronously designed in partnership with Indigenous educators and/or community leaders to create visual recordings and/or written professional learning materials for OST educators to better understand Indigenous knowledge systems. This approach models UDL frameworks for providing multiple means of engagement and representation.

For educators working with multilingual youth, immersive professional learning experiences can include short professional learning sessions in a foreign language to cultivate empathy among educators about what it is like for multilingual learners.

“During an immersive professional learning session designed to foster empathy through experience, a Syrian teacher taught a session in Arabic. First the way you would teach any other Arabic lesson, where the teachers were completely lost, and then with scaffolding. This gave teachers firsthand experience of learning in a different language.”

– OST Educator

Include opportunities for educators to build their cultural competency. All educators bring particular worldviews to their OST sites. These worldviews affect how they connect with whatever curriculum they are provided, as well as how confident they feel to adapt that curriculum to their teaching and how they respond to the youth they work with (Chinn et al., 2014).

Final Considerations

During the analysis of the relevant research and focus group responses on promising practices for STEM learning for diverse learners, common themes emerged. These themes tie back to our guiding framework of culturally sustaining, asset-based approaches and UDL. In paying attention to the considerations of specific learners, such as the three groups focused on in this guide (Indigenous learners, multilingual learners, and learners experiencing differing physical and/or sensory abilities), other learners ultimately benefit as well from the strategies employed. Some of the more important general, crosscutting strategies for inclusive OST STEM education include the following:

- Involve representative family and community members as much as possible.
- Challenge your assumptions and get to know your learners—ask and pursue the question of what relevant connections can be made.
- Create meaningful connections to the daily lives and concerns of learners.
- Ask learners what they need and help them build agency in STEM.
- Do not single out learners as being from a “different” audience.
- Use inclusive language.
- Design activities to be in collaboration with other learners.
- Provide multiple means of access to learning and communication/expression of understanding.

Applying these themes in the design of STEM OST programs, curricula, and professional learning will result in powerful programs that celebrate diversity and provide equity for all learners.

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Appendices:

Examples From the PLANETS Curriculum

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About the Examples

The examples provided in this section are drawn directly from the PLANETS curriculum and are designed to be used or adapted in out-of-school-time (OST) STEM settings. However, many of these examples are also supportive of inclusive strategies that would be equally productive for use in formal K–12 learning environments as well. Each example provides additional details about the use of that specific inclusive strategy and provides a snapshot of how these learning supports are positioned in the PLANETS curriculum. While the examples are grounded in particular PLANETS units, they are intentionally structured so that educators can modify them to fit their own context, learners, and program goals.

Across the examples, you will see how the research-based, inclusive practices recommended in this Practical Guide came to life in the PLANETS curriculum materials. These approaches reflect a core principle of PLANETS: that all learners' identities, languages, experiences, and ways of knowing are essential assets for STEM learning. Therefore, across these examples you will see intentional instructional strategies, curriculum design, and professional learning that strategically support meaningful participation for learners by fostering a sense of belonging and deepening their engagement with STEM concepts.

We encourage you to explore these examples as both immediate resources for your own practice and as entry points

into the full PLANETS curriculum. Each example is connected to a larger sequence of learning experiences available on the PLANETS website, where you can find complete units, educator guides, and additional STEM learning resources. We invite you to explore the PLANETS curriculum by visiting <https://planets-stem.org/>.

Appendix A: Features of Accessible and Welcoming Learning Environments



Example: Accessibility Checks

Accessibility checks, as shown below, can be done at the beginning of a learning activity and during transitions. Checking accessibility normalizes the conversation around access needs, encourages learners to think about and communicate their own need, and remind learners that access needs can change from one moment to the next. Accessibility checks give learners power, voice, and choice.

EDUCATOR GUIDE

Accessibility Check

Have learners go around a circle and share their names and access needs. Access needs are things they might need to fully participate and feel comfortable in an activity or space. They can be anything that helps people learn, communicate, move around, or feel safe and included. As needed, share first yourself and give some examples, such as “I need short breaks during long activities to stay focused,” “I need to refill my cup of water,” “I feel more comfortable lying on the floor,” or “I need pictures to help me understand what we are learning.” Learners can also say “I’m still thinking about my access needs” or “All my access needs are met, check.” Note that learners may not be comfortable sharing their needs until after several days of participation.



Example: Family Connections Invitations

Educators are encouraged to actively involve families and caregivers throughout the unit. Flyers, like the samples shared below, invite families to a celebration at the end of the unit and offer prompts to inspire storytelling at home. Educators are also encouraged to invite guest speakers from the community who have cultural expertise and to provide prompts that connect to the unit's themes. Families can explore adapted resources online, allowing learners to engage with their families at home. Together, these tools empower families as knowledge-holders and active participants instead of passive observers, fostering connections between formal learning and home/community contexts.



PLANETS

STEM LEARNERS & Families

Remote Sensing Learners & Families

- + ACTIVITY AT HOME AND TRANSLATABLE GLOSSARIES
- + COOL LINKS
- + VIDEOS to WATCH
- + GAMES TO PLAY AND DYK FACTS
- + Downloads

Pick 1 or 2 story prompts to discuss at home

Can you tell me a story about...

- ... a technology or tool that made a big difference in your life?
- ... something you built
- ... a time when you realized you had missed before
- ... our landscape / the
- ... an animal that was
- ... building something
- ... something you built
- ... how did you improve
- ... a time when you shared

Do you think there has ever been life on Mars?

We will be doing activities based on NASA science where your young engineer will create remote sensing device to investigate the evidence for past life-supporting environments on Mars!

These activities were designed to be inclusive. We invite you to share your own, your child's, and your community's knowledge on this topic.

How has a tool or technology made a difference in your life?

Can you share a story with our program?

WAYS TO GET INVOLVED

- Reach out to your program to share knowledge or suggest someone else who might do this.
- Come to the Engineering Showcase.
- Share what you know with your child at home. See the story prompts on the back.
- Scan the QR code to the right or visit <https://planets-stem.org/> to learn more.

PLANETS

NASA

Grantee



For more details on these example, see the [Remote Sensing unit in the PLANETS curriculum](#).

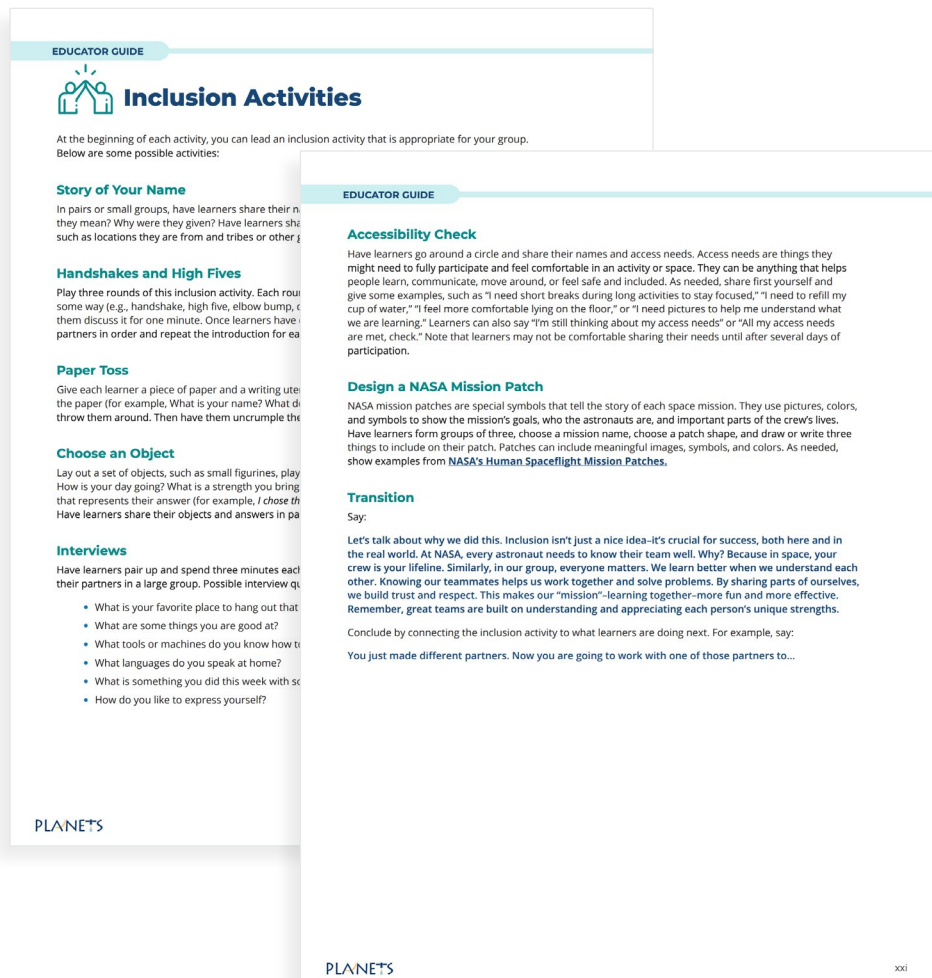
(visit: planets-stem.org/remote-sensing)

Appendix B: Instructional Practices for Building Relationships



Example: Inclusion Activities

Educators are encouraged to begin with an inclusion activity prior to starting the PLANETS learning sequence. This helps learners to better understand one another, build trust and respect, and work together to solve problems. Inclusion activities are framed to learners as important for both their learning and for the work of every astronaut at NASA, as they work together to understand and appreciate each person's unique strengths. See more details about two PLANETS inclusion activities on the next page.





Inclusion Activities (cont.)

Names are an important part of a learner's culture and personal identity. In the "Story of Your Name" activity, as shown below, educators are encouraged to ask about, practice, and model pronouncing learners' names correctly, and learners are encouraged to share the stories behind their names.

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Story of Your Name

In pairs or small groups, have learners share their names and stories behind them. For example, what do they mean? Why were they given? Have learners share other important information about their identities, such as locations they are from and tribes or other groups they belong to.

Objects can serve as powerful tools for self-expression and reflection. In the "Choose an Object" activity, as shown below, educators lay out a variety of items such as small figurines, playing cards, or craft supplies, then pose a reflective question to the group. Learners select an object that represents their answer and share their choice and reasoning with peers in pairs or small groups, creating opportunities for personal connections and appreciation between learners.

EDUCATOR GUIDE

Choose an Object

Lay out a set of objects, such as small figurines, playing cards, or craft supplies. Ask a question (for example, How is your day going? What is a strength you bring to the group?) and have each learner choose an object that represents their answer (for example, *I chose the owl because I am good at watching what is happening*). Have learners share their objects and answers in pairs or small groups.



For more details on these example, see the [Water in Extreme Environments unit in the PLANETS curriculum](https://planets-stem.org/water-in-extreme-environments).

(visit: planets-stem.org/water-in-extreme-environments)

Appendix C: Instructional Practices for Translanguaging and Storytelling



Example: *Our Ideas* Poster

The *Our Ideas* poster template is an instructional tool used in PLANETS to support and capture learners' authentic language and ideas during real-time sense-making and discussions. You can see in the example circled below that the learner's own ideas about hazards are captured in their home language (e.g., Yiyáh is a Dine expression meaning “scary”).

Our Ideas about Space Hazards Science



How can we mitigate hazards on a particular NASA mission?

Adventure 1, 6, 7

Why is it important to make hazards safer?



- Create safe environment for astronauts
- To keep everyone safe
- So nobody gets hurt
- To live "BLE Best life ever!"
- Survival
- Communities can continue to live

Adventure 1

Add learner's index cards here

Adventure 1

How do people stay safe from everyday hazards?

Adventure 2

What is a hazard?



Adventure 2

-Dangerous
-Something that will harm me



Scary
Yiyáh

Adventure 2

Mitigate

-to make a danger (hazard) less severe or painful



Adventure 2



Our Ideas Poster (cont.)

The posters are not meant to simply display and front-load vocabulary but instead develop over time through each PLANETS learning activity, called Adventures, as shown below. During each Adventure, the educator listens for and adds the language that learners use in the moment, thus validating their ideas, providing feedback, and supporting language development. In PLANETS, a template of the Our Ideas Poster is provided with setup instructions and examples.

How can we mitigate hazards on a particular NASA mission?

Adventure 1, 5, 7

Why is it important to make hazards safer?

-Create safe environment for astronauts
-To keep everyone safe
-So nobody gets hurt
-To live "BLUE Best life ever!"
-Survival
-Communities can continue to live

Adventure 1

How do people stay safe from everyday hazards?

Adventure 2

What is a hazard?

Adventure 2

-Dangerous
-Something that will harm me

Scary
Yiyah

Adventure 2

Mitigate

-to make a danger (hazard) less severe or painful

Adventure 2

How do NASA missions mitigate hazards in space?

Adventure 1

Going to the Moon

(H) -Too hot/cold
(R) -scratchy soil
(R) -meteor impact
(R) -low gravity
(R) -micro impact

Adventure 6

Robots studying an Asteroid

-Space radiation (R)
-Scratchy soil (R)
-meteor impact (R)
-Where to get energy? (R)
-Low gravity (R)
-Micro impact (R)

Adventure 6

Space Hazards

-Dust storms -hard to mitigate
-Meteor impact -Very difficult!
-Low gravity
-No food/water/air
-Radiation
-micro-impact

Adventure 4

Rocket Launch from Earth

(H) -Bad weather
(R) -Explosion
-Aircraft traffic (R, H)
-Engineers not ready! (R, H)
-Flight path not clear (R, H)

Adventure 6

Traveling to Mars

-Takes a long time to travel (R)
-Space radiation (R)
-Food/water/air (R)
-meteor impact (R)
-Where to get energy? (R)
-Low gravity (R)
-Micro impact (R)

Adventure 6

What hazards exist where we live and how do we mitigate them?

Adventure 3

Hazards: Mitigations for hazards:

-flooding -sand bags
-bears attacking chicken coops -electric fences
-wet floor in the cafeteria -let students know the floor is wet.
-cracked sidewalk -fix sidewalk

Adventure 3

What natural hazards do people on Earth face and how do they mitigate them?

-Flooding (hard to mitigate)
-Earthquakes -very difficult to rebuild
-Lightning strikes
-Tsunamis

Adventure 3

Natural Hazards on Earth

-Tornadoes Chail bil haagal
-Snow storms
-Climate change
-Volcanoes بركان

Adventure 3

Using NASA Science & Engineering to solve a problem in our community

-Dust storms (H)
(R) -Radiation
(R) -Sea level rising
-Where to find water (R, H)
-Studying unknown species (H)

Adventure 6

-Find ways to mitigate hazards at home, school, or in a neighborhood.
-Learn about NASA missions
-Learn how to create or control robots.

Adventure 7



For more details on this example, see the [Space Hazards unit in the PLANETS curriculum](#).

(visit: bit.ly/4pnZZGh)

Appendix C: Instructional Practices for Translanguaging and Storytelling (cont.)



Example: Inviting Learners to Share Their Stories

Learners are invited to step into the PLANETS experience by sharing stories of themselves and their communities. In this Space Hazards unit example, as shown below, learners are invited to share stories of locally relevant hazards. This approach honors the knowledge and experiences learners bring from their homes and communities, known as funds of knowledge. It created opportunities for learners to share their experiences and strengths.

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Storytelling (25 min.)

4. Say: **We all have stories. They can be stories we've heard from other people, stories we've watched or read about, or stories about things we have experienced ourselves. We experience stories every day in conversations, art, traditional craft, and online videos. Today, we're going to share stories about times we made a hazard safer in our homes, towns, or schools.**
5. Have learners turn to *My Safety Story*, pg. 10 in the Engineering Notebook. Say: **To start, everyone will have 15 minutes to think about a story to tell about making a hazard safer. Create some art that tells your story. You can write it down or write a poem that tells it, draw it, record it on a device, create a performance about it, or build something to demonstrate it.** Note that there are drawing and building materials on the Materials Table. During this time, check in with each group. If learners are struggling, consider sharing your own short story about hazards to spark ideas.



For more details on this example, see the
[Space Hazards unit in the PLANETS curriculum.](#)

(visit: planets-stem.org/space-hazards)

Appendix D: Designing Curricula With Multisensory STEM Activities



Example: Multisensory Supports

This spectroscopy lesson in the Remote Sensing Unit, shown below, invites educators to create tactile graphs that can be used with learners as they listen to the audio files, allowing them to be active participants. This multimodal approach supports Universal Design for Learning by providing multiple means of representation and engagement, allowing learners to access content through both tactile and auditory pathways. This approach engages learners' multiple senses to deepen their understanding and places value on learners' diverse strengths.

EDUCATOR GUIDE

Activity 6 Materials Preparation (60 min., at least two days ahead of time)

Ahead of Time

1. Review the *Our Ideas* poster "In-Use Example" in the [Prep & Setup Guide - Examples \(PDF\)](#) to help you think about what to add to the *Our Ideas* poster during the discussions in this activity.
2. Determine how you will share the audio files on the day of the activity with the whole group. You have the option to [download the audio files](#) or access [audio files online \(weblink\)](#).



Support Learner Differences

Although it is listed as optional, all learners will benefit from interacting with a tactile version of the spectra, and it will make for a more enriching experience. Learners trace the reflectance lines with their fingers as they listen to the audio files, making them active participants versus passive listeners. This will strengthen their connection to understanding the changes in the light that comes from the materials.

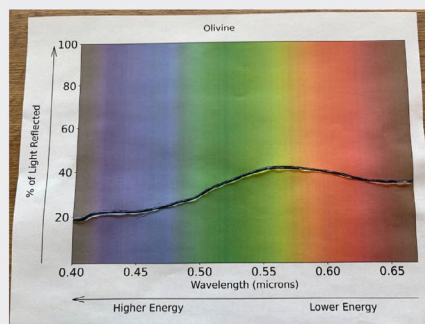
Print these on [swell paper with Braille at this weblink](#) or prepare a tactile model by adding a line of glue or puff paint to the data line, to each of the axes, and on either side of the visible spectrum of *Electromagnetic Spectrum*, *Red Paint*, *Green Paint*, and *Olivine*, pgs. 8-11 in the [Science Notebook \(PDF\)](#). Ensure you have a space to let the graphs dry.

Consider sprinkling the glue with a bit of fine sand or glitter to add additional texture (see photo below). Make enough for half the learners in your program to access the tactile graphs at once.



Teaching Tip

If you are planning to make the tactile graphs, consider also preparing the tactile graphs for Activity 7 at the same time. See [Activity 7 Materials Preparation](#), pg. 80.



A tactile version of the visible portion of olivine's spectrum



For more details on this example, see the [Remote Sensing unit in the PLANETS curriculum](#).

(visit: planets-stem.org/remote-sensing/#science)

Appendix E: Educator Instructional Supports



Example: Instructional Support Tips for Learning

Within each activity, several strategic tips are included for educators. Video playlists are available to highlight inclusive strategies that work for different learners.

Please see the following pages for a closer look at examples of instructional tips.

VIDEO

Indigenous Learners

How to Support Learner Differences



EDUCATOR GUIDE

Instructional Support Tip: Connecting Across Activities	Purpose: Highlights ways that the activities connect within the pathways and across the disciplines of engineering and science.
Instructional Support Tip: Support Learner	Purpose: Provides instructional supports during the activity that help.

EDUCATOR GUIDE

Instructional Support Tips for Learning

Within each activity across the Water in Extreme Environments unit, several strategic tips are provided as opportunities for additional instructional support. These tips are guided by the following PLANETS core design principles:

- Support Thinking
- Teaching Tips
- Connecting Across Activities
- Support Learner Differences
- Level Up

The table below provides guidance on the purpose and use of each of the tips found within the activities.

Instructional Support Tip: Support Thinking	Purpose: Provides ideas for educators to productively support learners' thinking, such as
	• suggestions of targeted language to use with learners to increase social emotional supports. • things to emphasize during student collaboration. • language that explicitly helps students to realize they are working, thinking, and looking like engineers or scientists (metacognitive and representation/identity/confidence in STEM). • additional resources that may enhance student engagement/thinking about the current instructions of the activity (e.g., videos, audio).
Instructional Support Tip: Teaching Tip	Purpose: Provides additional recommendations for educators with regards to the mechanics of the activity, such as
	• modifying materials. • grouping and/or roles of learners during parts of the activity based on materials, timing, and engagement. • additional procedural tips to increase effectiveness of investigations and designs. • modifying timing of activities with different procedures.

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Example: Instructional Support Tips for Learning (cont.)

EDUCATOR GUIDE



Instructional Support Tips for Learning

Within each activity across the Water in Extreme Environments unit, several strategic tips are provided as opportunities for additional instructional support. These tips are guided by the following PLANETS core design principles:

- Support Thinking
- Teaching Tips
- Connecting Across Activities
- Support Learner Differences
- Level Up

The table below provides guidance on the purpose and use of each of the tips found within the activities.

Instructional Support Tip: Support Thinking



Purpose:

Provides ideas for educators to productively support learners' thinking, such as

- suggestions of targeted language to use with learners to increase social emotional supports.
- things to emphasize during student collaboration.
- language that explicitly helps students to realize they are working, thinking, and looking like engineers or scientists (metacognitive and representation/identity/confidence in STEM).
- additional resources that may enhance student engagement/thinking about the current instructions of the activity (e.g., videos, audio).

Instructional Support Tip: Teaching Tip



Purpose:

Provides additional recommendations for educators with regards to the mechanics of the activity, such as

- modifying materials.
- grouping and/or roles of learners during parts of the activity based on materials, timing, and engagement.
- additional procedural tips to increase effectiveness of investigations and designs.
- modifying timing of activities with different procedures.

Example: Instructional Tips for Learning (cont.)

EDUCATOR GUIDE	
Instructional Support Tip: Connecting Across Activities 	Purpose: Highlights ways that the activities connect within the pathways and across the disciplines of engineering and science.
Instructional Support Tip: Support Learner Differences 	Purpose: Provides just-in-time supports during the activity that help educators ensure they are meeting the needs of all STEM learners—especially Indigenous learners, emergent multilingual learners, and learners experiencing differing physical and/or sensory abilities—such as • ways to support multiple pathways for ensuring all learners can equitably engage in the activity. • strategic peer grouping(s) to enhance engagement equity. • additional challenges or ways to increase the learning rigor for learners who are ready. • additional resources that increase equity to ensure that all learners can engage effectively in the activity (e.g., videos, audio). Unique icons are used in PLANETS activities to help educators quickly identify specific tips that may apply to their learners:  Multilingual learners  Indigenous learners  Learners with diverse abilities  Engaging all learners
Instructional Support Tip: Level Up 	Purpose: Provides supplemental guidance to educators facilitating activities, such as • ways to make the activities more inclusive to all STEM learners. • extensions to broaden both content and options provided within each activity. Note that time estimates for Level Up activities are provided separately from the main activity timing.

 For more details on the professional learning supports in PLANETS, visit the [‘Getting Ready to Teach PLANETS’ webpage](#). These supports are also embedded in each PLANETS unit.

(visit: planets-stem.org/getting-ready-to-teach-planets)