A Teacher's Guide to Educational Media for Diversity and Equity

Selecting and contextualizing media for the K-12 science classroom

GBH Education

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Who We Are

GBH is the public media leader behind NOVA, FRONTLINE, and AMERICAN EXPERIENCE and other general audience programming, and behind innovative children's programs on PBS, ranging from favorites like ARTHUR to new groundbreaking shows like **MOLLY OF DENALI**, the first nationally distributed children's show to feature an Alaska Native as the main character and protagonist

GBH Education is a long-time producer of educational media spanning preK-12, with a special focus in science, social studies, and civics. We are uniquely positioned to develop and test science resources for diverse learners as a major contributor of educational media to the PBS network, and the co-manager and science lead on **PBS LearningMedia**, a free service for educators and students, where we have published over 2,500 middle and high school STEM resources.

In addition, we are the architects of award-winning community-based initiatives such as **Design Squad Global**, a problem-based learning model of engaging youth and educators around the world to draw engineering inspiration from their own lives, communities, and cultures. We host a breadth and depth of expertise in-house, from educational practitioners, educational researchers, and STEM curriculum experts, to media producers and game designers, and also collaborate extensively with educators, schools, researchers, and community organizations.

Our Mission

We work with communities to research, develop, and distribute quality media-integrated resources to support the equitable learning and development of children and youth.

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GBH Education

Introduction

GBH Education (GBH), in collaboration with NASA, produced a large body of digital media resources as part of an initiative called ***Bringing the Universe to America's Classrooms*** (https://mass.pbslearningmedia.org/collection/universe/), to support K–12 instruction in earth and space science [1]. These free resources, available via **PBS LearningMedia** (pbslearningmedia.org), relate to core ideas defined by the Next Generation Science Standards (NGSS) and emphasize engaging students with phenomena and science and engineering practices. Supplementary in nature, these resources are meant to enhance teachers' curricula, not replace it. For each grade band, there are sets, or collections, of resources. Each set relates to a single topic and links to level-appropriate disciplinary core ideas (DCIs). The resources are designed to engage students in phenomena and to provide opportunities for them to engage in science and engineering practices. In addition to production, in this initiative GBH also engaged in soliciting input from teachers and subject matter experts, extensive formative research with teachers to develop and refine the resources, educator outreach and awareness-generation activities, teacher professional learning events, and efforts to further principles of diversity, equity, inclusiveness and accessibility.

In its commitment to supporting diverse learners, *Bringing the Universe* created A Framework for Diversity and Equity in K-12 Science Educational Media [2]. An Advisory Group (see *Acknowledgements* for list of members), identified four key themes as the foundation of the Framework: anti-deficit perspective, and relatedly: representation, science representation, and access and engagement.

This Teacher's Guide to Educational Media for Diversity and Equity distills the findings of the Framework into relevant, actionable principles to support science educators in selecting and contextualizing media to promote culturally and linguistically responsive teaching and learning in their classrooms.

We hope you find the contents of this guide useful. Please direct any questions or feedback to education@wgbh.org, with the subject line: K-12 Science Diversity.

Teaching from an Anti-Deficit Perspective

The foundational principle of this Teacher's Guide to Educational Media for Diversity and Equity is to teach from an **anti-deficit perspective**.

K-12 formal schooling in the United States has historically been developed from a dominant, white, middle-class perspective [3]. Historical stereotypes about who does or can do science still persist today. This same perspective has also affected science learning in schools, including *what* is taught and learned and *how* it is taught and learned. This means that minoritized students [4] are often expected to learn science in ways established by curricula and pedagogy geared towards white, middle-class backgrounds. This also means that current science teaching and learning practices often render invalid the lived experiences and expertise of minoritized students as barriers to overcome. Minoritized students face many challenges including "stereotype threat" that stems from mainstream perceptions and portrayals that "people like me" do not belong in science (Steele, 1997). When students do not associate science with people who look like them, speak the same language, or come from similar communities, they can see science as "not for me" (Johnson, et al., 2011).

In contrast, this guide recognizes that much learning occurs both inside and outside of the classroom [5]. By taking an assets-based approach, this guide will help you leverage media to privilege students' **funds of knowledge**—communities' historically accumulated and culturally developed bodies of knowledge and skills—in the classroom [6]. The Guide also builds on other asset-based pedagogies such as culturally relevant pedagogy [7] and culturally sustaining pedagogies [8]. Such pedagogies can support the development of minoritized students' science identity, which the National Research Council has identified as fundamental for engaging in lifelong science endeavors [9].

Anti-deficit Perspective

An anti-deficit perspective privileges students' cultures, experiences, and skills and recognizes that much learning occurs both inside and outside of the classroom

Funds of Knowledge

The abilities, skills, knowledge, and worldviews that students bring from their families, communities, and lived experiences

Educational media that can help you promote an anti-deficit perspective in your classroom will:

- position students, their families, and their communities as having positive contributions to science and science learning;
- position students and communities as capable of learning and doing science;
- recognize how students and communities have been historically marginalized and not included in science; and
- recognize and make visible existing connections minoritized students and communities have with science.

This Guide offers three intersecting Principles for teaching science from an anti-deficit perspective:

People Representation: Who does science?

Access and Engagement

Science Representation: What is science?

People Representation: Who does science?

There are many reasons for the underrepresentation of minoritized groups in the sciences [10]. While inequities related to school resources and academic opportunities, as well as differential teacher quality certainly have an impact, this guide focuses on the impact of curricular and instructional biases based on white, middle-class, monolingual and monocultural norms and ideas [11]. Some of these reasons include:

1. Minoritized groups face **stereotype threat**; they are negatively stereotyped as not being as smart or as good in the sciences as others [12]. Researchers found that even when minoritized girls performed science in school-sanctioned ways, such as asking scientific questions and testing variables while experimenting, they did not receive recognition for their learning. In one case, a teacher was surprised that a minoritized girl earned an A in her class; the teacher only saw the student as Black student and from a low socio-economic status background, and failed to recognize her achievements as a scientist.

2. Students from minoritized groups may **not self-identify with science** [13]. Science identity has been identified by the National Research Council as fundamental for engaging in lifelong science endeavors—at a personal and professional level. The ASPIRES project, a longitudinal study of U.S. youth's science and career aspirations age 10-14, found that students viewed 'scientists as brainy,' and therefore 'not for me [14].' Years of research on U.S. students' perceptions of scientists show that stereotypical perceptions of scientists, including who does science and the work that scientists do, persist [15]. Brown (2019) discusses how stereotypes about scientists pervade society, even in popular television shows that depict scientists as white, awkward men. Students' lack of role models, particularly those who look like them and come from similar communities, can lead to a disassociation with science [16].

Stereotype Threat

The idea or feeling that some students may experience that they do not belong because of their social group; e.g. "people like me don't do science

Science Identity

Stereotypes can influence how people perceive themselves and how they identify with science.

People Representation: Who does science?

3. Students **should see themselves reflected in the science classroom.** This may be through representation of scientists with similar backgrounds (e.g., race, ethnicity, socio-economic status, particular first language, English Learner, etc.) or who have similar interests, values, and cultural practices. For example, they should learn about Mae Jemison, the first African American astronaut, or the contributions of Persians to astronomy, and Indigenous communities to navigation. Science teachers may also include examples of youth and communities doing science, including intergenerational groups doing science together. Students should also have opportunities to learn about the cultural and historical contributions of minoritized populations.

While more diverse images of people who do science should be included, it is important that these images are authentic and do not essentialize or reinforce stereotypical ideas related to race, class, gender, etc.

People Representation: Who does science?

Selecting Media

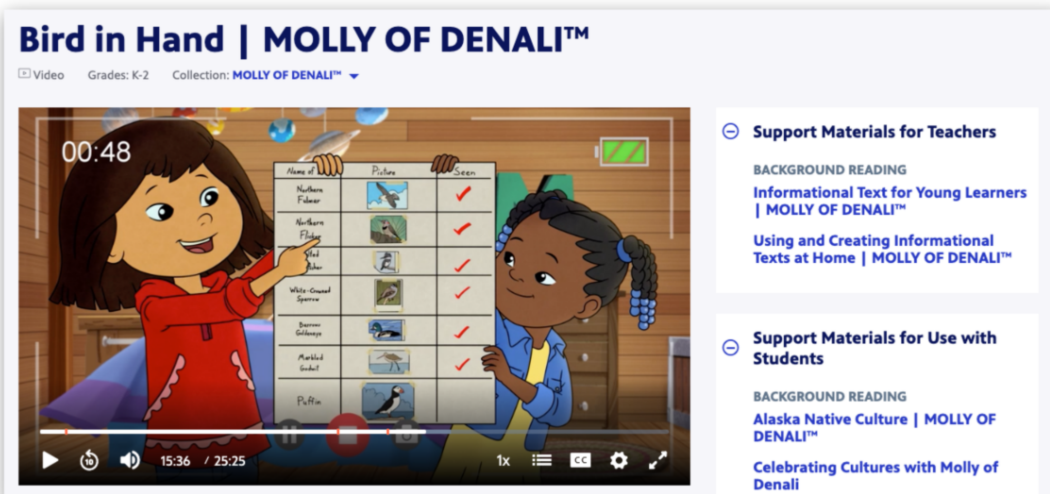
We offer the following guiding principles for selecting media to promote diverse and equitable representation of people in science:

Media resources include representation of people from diverse backgrounds (e.g., race, ethnicity, socio-economic status, English Learner, etc.), including:

- people who have a variety of interests, values, and cultural practices
- youth, communities, professional scientists, and intergenerational groups doing science
- the contributions that minoritized people and communities have made and are making in science

Example: Molly of Denali

- includes Alaska Native and Black youth characters doing science/ engaging with the practices of science
- shows the contributions that Alaska Native communities have made toward science; in this case toward the study of birds



In teaching this resource, you might:

- prompt students to observe birds in the places where they live

Each media resource (video, game, image, simulation, etc.) is accompanied by supporting materials: a Background Reading, Teaching Tips, and Discussion Questions. Some also include handouts and activities.

Science Representation: What is science?

Science is often represented as facts and numbers, and as a discipline, it is viewed as neutral, objective, and universal. On the contrary, both science and science education have also historically focused on particular ways of knowing and doing science that is referred to as "Western science" [17]. It is important to include multiple perspectives in the science classroom because:

1. Personal, cultural, and historical context influences which questions are investigated. For example, someone living in a coastal community facing rising sea levels may study and understand climate change differently than someone living in a landlocked state. Cultural practices may also influence how people understand science. For example, people who interact with land regularly for food (e.g., farming, fishing, hunting) or livelihood (e.g., mining, logging) may ask different questions about climate change from those who interact with land for recreational purposes.

2. Context also influences how scientists investigate questions. Many scientific understandings have been developed based on data and studies of homogenous populations. This particularly true in the medical field. For example, the majority of asthma biomedical research has been performed on populations of European descent. However, a study found that only 5% of genetic traits linked to asthma in European Americans applied to African Americans [18]. There is also a history of mistreating minoritized populations in the name of science. In the Tuskegee study, Black men participated in a study of syphilis where they were studied without informed consent and were not given treatment for their disease [19].

3. Observations are also influenced by culture and social practice [20]. In one study, United States college students and Indigenous Panamanian Ngöbe adults looked at illustrations from a children's book on coyote and badger hunting, based on the research of wildlife biologists. The college students interpreted the relationship as competitive, while the Ngöbe adults viewed it as cooperative. The two groups' differing cultural and contextual lenses led them to form different hypotheses about the relationship between coyotes and badgers, with the Ngöbe adults' hypothesis aligning with current understanding of coyotes' and badgers' hunting behaviors [21].

Science Representation: What is science?

4. Cultural and historical perspectives can influence how scientists interpret and represent data. For example, Darwin's view of the unity of life—the relationship among organisms—is represented by a branching tree, an image adapted from Victorian practices of tracing family lines and property inheritance [22]. In contrast, Helmreich's work found that microbes engage in lateral gene transfer within generations across species and vertical inheritance over generations, leading to representations of the connections between species as a web. It is important to represent the varied ways of doing science, including the cultural and historical nature of science.

5. Science is dynamic. While science is often presented as static, it is in actuality constantly changing and evolving over time as we gain new evidence and ways of thinking about the world. The Institute for Systems Biology, located in Seattle, Washington, is one example of an organization that crosses multiple disciplines and topics. Rather than limiting investigations through the lens of genetics, geneticists work with computer scientists, engineers, and mathematicians to map and visualize genomes in order to answer scientific questions. Through interdisciplinary approaches, scientists apply new perspectives, including methodologies, to investigate questions. Scientists increasingly work in interdisciplinary teams to solve today's problems, such as climate change. Thus, it's important to represent the diverse processes and practices of science. It is also important to provide students with opportunities to engage in science practices themselves, so that they can see themselves as participants in the dynamic processes of science!

While there are standards for observations and the reliability and validity of data, there is not one way to conduct science, science is not conducted in a vacuum, and there are multiple knowledges and ways of knowing [23].

Science Representation:
What is science?

Science should not be presented as facts to be memorized. Scientific data and theories can be analyzed and critiqued. Students should have opportunities to engage in science practices and study how theories change [24]. Schwarz, Passmore, and Reiser (2017) state:

> *An observer should be able to walk into a science class on any day and ask a student, "What are you trying to figure out right now?" The intellectual aim of any work in the science class should be clear to everyone. Rather than stating, "We are learning about photosynthesis or plate tectonics," students should be able to say (and believe!), "We're trying to figure out how the tiny seed becomes this huge oak tree" or "We're trying to better understand why volcanoes and earthquakes happen more often in some parts of the world." These examples illustrate how the students are figuring out the world and illustrate a sense-making goal in the classroom.* [25]

Science education should not be about solely the content, but also about how students are learning about a science concept through doing science.

Science Representation: What is science?

Selecting Media

Rather than delivering informational "facts" about science concepts, the media you choose for your classroom should provide students with the opportunities to ask questions, make observations, and construct models. For example, media might include sped-up videos of the moon over a month so that students can more quickly observe the changing shapes of the moon over a month. Accompanying materials, such as lesson plans and student handouts should scaffold students asking questions and the process of planning and carrying out investigations.

We offer the following guiding principles for selecting media to promote diverse and equitable representation of science:

Resources show the different motivations behind, processes and underlying biases of science

- ☑ Why and which phenomena are investigated; for what purposes?

  e.g. Eurocentric worldview might drive precipitation data gathering for purposes of thinking about how it impacts natural resources we consume. An indigenous worldview might drive precipitation data gathering to inform how humans can better maintain harmony with nature

- ☑ How are phenomena investigated?

  Rather than presenting science as facts, students learn how scientific knowledge is created in different cultures and in different ways and how one's culture may shape the types of data gathered to support, evolve, or refute a theory

- ☑ How are theories developed?

  e.g., students learn how theories are developed through observations (data collection), analysis (looking for patterns in data), and using data to support theories, in different communities

Science Representation: What is science?

- How does scientific knowledge evolve?

  e.g., students learn how the atomic theory has changed over time as new evidence becomes available through new technologies and new ways of knowing

- How do contextual factors (e.g., location time, prior knowledge, and culture) influence scientific processes?

  e.g., how climate change affects different locations and communities differently, including what is studied

- The cultural and historical nature of science

  e.g., how Indigenous knowledge perspective of the cooperative hunting behavior of coyotes and badgers or how kites and falcons intentionally spread fire [26]

Resources address the relationship between science and society

- Considers how the process of science and science knowledge is used and can impact communities in different ways

  e.g., The Tuskegee study, where Black men participated in a study of syphilis where they were studied without informed consent and were not given treatment for their disease, or satellite images of the coastline of Cape Cod show how hurricanes have affected the land over multiple decades while we may not have data for how hurricanes affect other areas (or only have more recent data)

- Provides opportunities for students to ask questions about how science and its knowledge-generating tools, and processes can be used to help create the world(s) they, their families and communities want to live in

  e.g., prompt students about how they would redesign homes in their community to better respond to climate change; what alternative building materials they might use, etc.

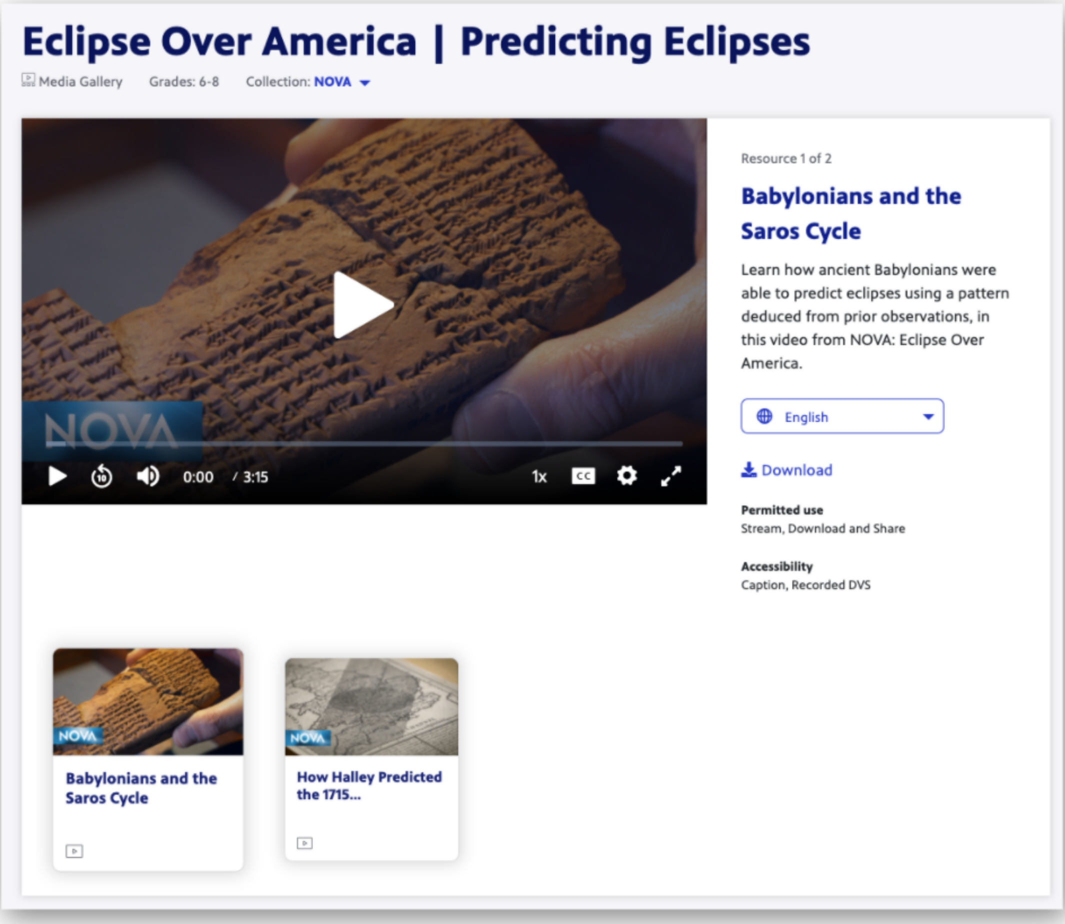
Science Representation: What is science?

Example: Eclipse over America

- shows the different motivations behind, processes and underlying biases of communities who study eclipses throughout history, starting with the Babylonians
- addresses the cultural significance of eclipses in Babylonian society

In teaching this resource, you might:

- ask students to brainstorm potential reasons for studying eclipses in their community



Each media resource (video, game, image, simulation, etc.) is accompanied by supporting materials: a Background Reading, Teaching Tips, and Discussion Questions. Some also include handouts and activities.

Access and Engagement: How do students learn science?

Learning science can be perceived as similar to border crossing. Many students may need to cross borders between their everyday lives outside of the classroom—their life-world—to the subculture of "school science"—the practices, values, and beliefs for what counts as science learning in the United States since the two "worlds" are often treated as distinct. Because school science, as is true with typical school-based education, is often guided by historically Western ideals, learning science is a process of assimilation; where the culture of science is at odds with a student's life-world, the student is forced to abandon or marginalize her/his/their life-world [27]. In crossing these borders, some students may face additional language or cultural barriers.

Let's take a minute to examine the role of language in access to science learners. Students, especially ELs, may be confused by polysemous words, or words that hold multiple meanings [28]. For example, the word "quality" differs in meaning depending on context. The "quality" of water and air, as measured by scientists, may be different from how people think about "quality" in their everyday lives. Yet, science vocabulary instruction is tricky. When students are expected to memorize definitions without any experience with the science phenomena, they cannot contextualize their understanding of the vocabulary [29]. In addition, science vocabulary is often defined by other disciplinary vocabulary, which teachers do not always explain [30]. By ensuring that students first experience science phenomena (visually, etc.), teachers can then refer to the phenomena as a piece of non-linguistic context with which to explain the disciplinary language of science.

In order to bridge students' everyday lives to science learning, it is important to:

1. Emphasize the importance of place [31]**.** State and national standards and assessments often work towards uniform, standardized curriculum that often neglect place, thus cutting off connections between school and students' everyday lives. Place is not limited to physical geography, but also cultural and ecological context. Thus, place-based education can prevent the marginalization of students' life-worlds. Indeed, place-based education has also been shown to increase academic achievement. After a school district in Louisiana implemented a place-based approach to science learning, students' performance on state science assessments significantly improved [32].

Access and Engagement: How do students learn science?

2. Incorporate students' interests and experiences into the science classroom. Research has long shown that students learn science when they are able to connect to and build on their interests, knowledge, and experiences from their everyday lives. Researchers found that incorporating students' everyday knowledge and practices into a middle school food and nutrition unit increased active engagement in lessons and ultimately deepened learning [33]. Another study found that when youth were able to use drawing and signifying as part of a collaborative critique process, they both learned the target science concept and engaged in scientific practices [34]. Thus, it is critical to provide context for why students should learn about the science phenomena that are relevant to their lives.

3. Prompt students to challenge what they learn. For example, Western science classifies objects and organisms into living and nonliving; according to this classification, water and sun are non-living. In contrast, Indigenous perspectives view things like water and sun as living. By questioning the Western science classification system and how it presents relationships in ecosystems, students will be free to draw upon their own experiences (e.g., how water is used in their communities) to gain deeper understandings of the relationships and roles of objects and organisms [35].

4. Provide students with experiences with science practices and phenomena before introducing the academic language of science. It is also important to provide students with experiences with science practices and phenomena before introducing the academic language of science. Begin instruction with everyday language and encourage students to use their languages and experiences to make sense of science questions, concepts, models, etc. Media resources are particularly situated to include different languages, experiences, and modes, such as storytelling [36] or arguing [37]. It is also important to provide students with multiple ways to show their understanding (e.g., storytelling, visually, etc.).

Access and Engagement: How do students learn science?

Selecting Media

When choosing media for your science classroom, you should look for media that grounds curriculum concepts in students' lives and connect learning to societal impacts. For example, media resources supplementing a unit about nutrition and health could include interactive neighborhood maps, digital journals to record food labels in the home, and short videos covering societal connections such as food deserts, neighborhood design, and food advertising. Media should also offer multiple ways for students to engage in discourse. Finally, media resources should allow multiple opportunities for students to explore a concept and provide various ways that students can explain their understanding (e.g., drawings, graphs, models, writing, video).

We offer the following guiding principles for selecting media to promote access and engagement in science learning:

- [x] Resources provide examples that are relevant to students' lives and why they need to learn about the phenomena and allow them to make connections. Answers the "so what" question.

- [x] Resources build on students' and their communities' experiences.
    e.g., ask students to reflect on their experiences with weather where they have lived and visited

- [x] Resources show multiple examples of how phenomena occur in different contexts and why
    e.g., what do seasons look like in Boston vs. Seattle vs. Phoenix

- [x] Resources were developed with the help of youth and communities.

- [x] Resources provide multiple ways for students to engage with the materials.
    e.g., visually, audibly, different languages, etc.

Access and Engagement: How do students learn science?

- Resources allow students to use multiple ways to demonstrate their understanding

  e.g., storytelling, visually, drawing figures or diagrams

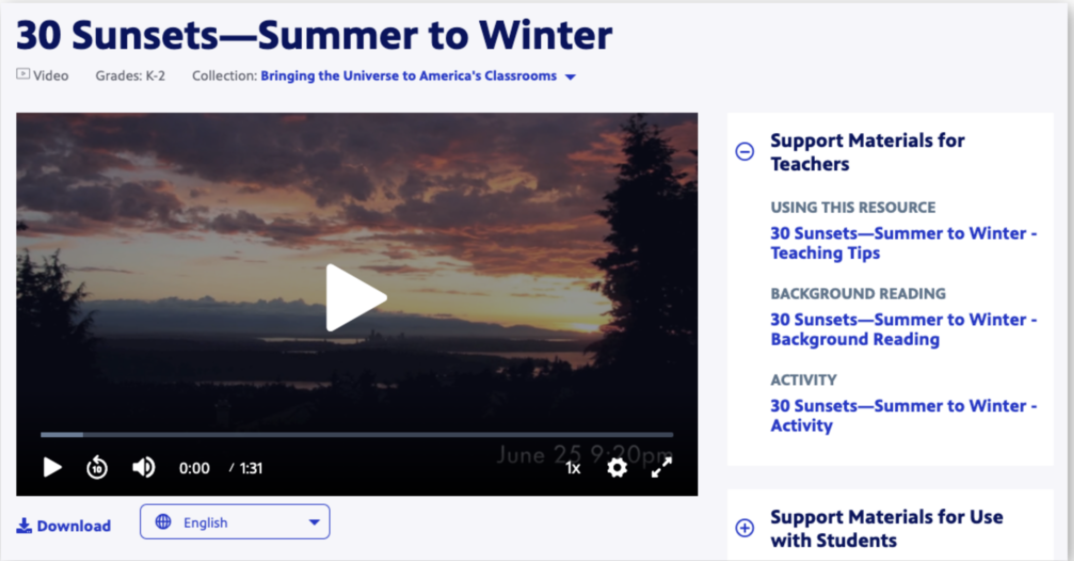
- Resources onboard students to the academic language of science.
  1. Students are provided with experiences with the science phenomena and practices
  2. Then, students are introduced to the academic language of science once a need is created
  3. Finally, students are provided with multiple opportunities to use the academic language of science

Example: 30 Sunsets - Summer to Winter

- includes an activity in which students can investigate the sun's movement in their own context
- includes a time-lapse video in both English and Spanish, as well as an activity, to allow students multiple ways to engage with the content

In teaching this resource, you might:

- begin by asking students to think about and share their experiences with sunrise/ sunset in their local context compared to what is shown in the video (filmed in the Pacific Northwest)



Each media resource (video, game, image, simulation, etc.) is accompanied by supporting materials: a Background Reading, Teaching Tips, and Discussion Questions. Some also include handouts and activities.

Notes

1. The original funded project ranged from 2015-2021, but GBH continues to maintain and add to various components of the initiative.

2. In our initial proposal, GBH targeted two sub-groups, students with disabilities using assistive technologies and English Learners. This work included ensuring our interactive student-directed lessons were available with audio language support in both English and Spanish. We also worked with our English Language Learner Teacher Advisory Council and produced and tested printable support materials for English Learners.

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4. In this report, the term 'minoritized' refers to people who do not come from white, middle-class backgrounds. Minoritized is used to recognize that people and communities are minoritized through action, such as educational policy that denies equitable access and opportunities for learning. Minoritized includes people that are marginalized due to race, ethnicity, gender, socio-economic status, dis/ability, etc.

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