Geophysics is Much More than You Think

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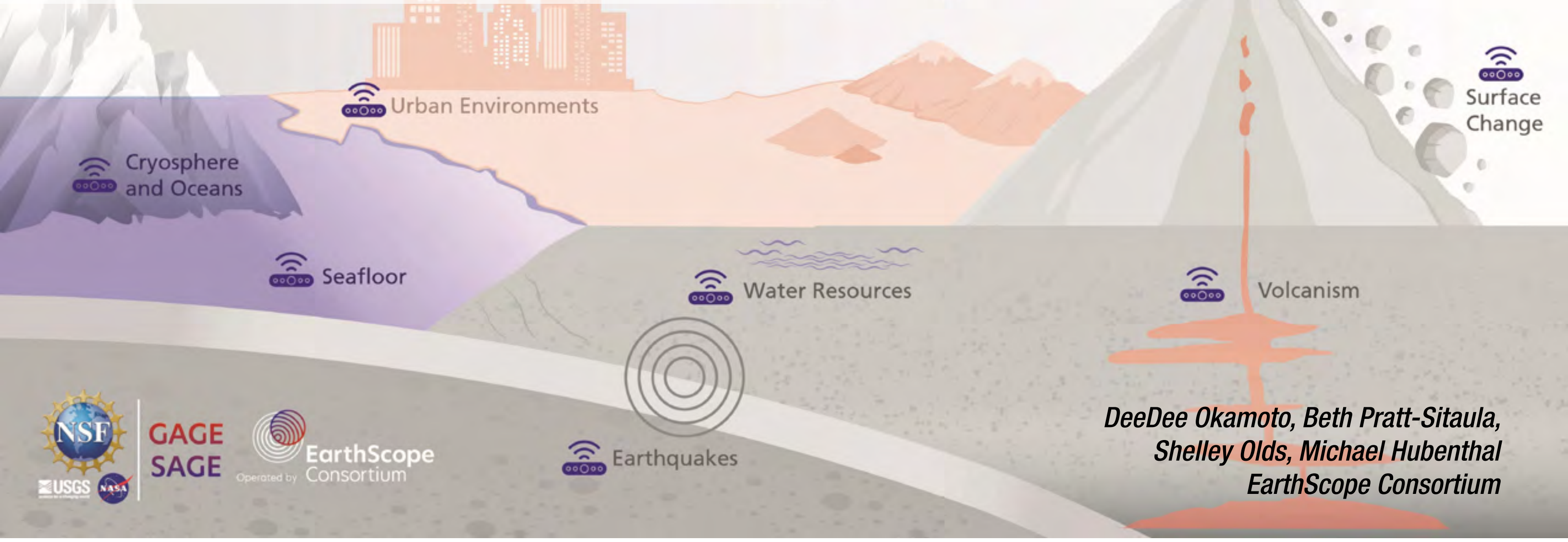

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Abstract

Student enrollment and interest in physics and geosciences may be limited by perceptions that these subjects are overly difficult, associated with environmental degradation, and offer limited career opportunities. However, geophysics, a multidisciplinary field, offers an engaging way to connect physics and Earth science concepts to real-world topics of interest to students. By highlighting geophysical instruments, like GPS, lidar, and InSAR, educators can align lessons with Next Generation Science Standards (NGSS) while exploring relevant topics such as groundwater depletion, tectonic motion, and atmospheric studies. This paper outlines how geophysics can make science content more meaningful, providing teachers with tools, strategies, and NGSS-aligned applications to foster student engagement and interdisciplinary learning.

Introduction

In recent years, fewer students are choosing to study physics and geosciences (Gwynne, 2024), often perceiving these fields as difficult (Keblbeck, 2024), linked to environmental degradation (Keane, 2022), or lacking career versatility (Boatman, 2023). As geoscience and/or physics educators, we know there are exciting and meaningful applications within these fields. Our challenge is to determine how best to convey this to students who don't see the real-world applications. Research from Johansen et al (2023) concludes that "If students can identify subject content as relevant, they are more likely to find assignments more meaningful, increasing both motivation, engagement, and achievements". Earth Science and Physics teachers can foster this interest by positioning geophysics as a tool to explore students' natural surroundings with real-life physics applications. Of course, this means that teachers need to understand geophysics and its applications. Below, we provide a very brief overview of geophysics techniques and the topics it is used to study. As we shall see, geophysics is about so much more than finding oil, studying earthquakes, or studying the internal structure of the whole Earth. Topics studied within geophysics are complex and interdisciplinary.

Geophysics

Geophysics is the study of Earth's physical processes and properties. It connects what we see on the surface, like earthquakes and volcanoes, to internal and external factors like Earth's internal structure, plate movements, or the influences of solar or atmospheric elements on Earth's surface. It also can be used to explore environmental issues such as glacial melting, groundwater pollution, and geohazard mitigation; the solutions to these challenges need an interdisciplinary approach (refer to Table 1 below). For example, understanding sea-level rise is not just an Earth science question; it also incorporates physics to explore the forces and energy driving glacial melting, oceanic thermal expansion, and their ecological impacts on marine and coastal systems. Geophysicists use high-precision instruments to detect millimeter changes in the Earth's surface and accurately measure the Earth's size, shape, mass distribution, and changes that occur over time: 9 Impacts of Geodesy and Introduction to Near Surface Geophysics.

These instruments use gravity, seismic and electromagnetic (EM) waves, and changes to the shape of the Earth to gather, transmit, and interpret data to understand phenomena like tectonics, ground deformation, and even droughts. For physics teachers, these technologies offer ways to teach Next Generation Science Standards (NRC, 2013) aligned concepts like forces, waves, and EM fields in a highly relevant context such as environmental monitoring (refer to Tables 2 and 3 below). For Earth science teachers, geophysics provides a fascinating way to explore how physics supports geosciences, giving students a better understanding of how data is collected and analyzed. For instance, students can investigate how ground deformation data collected by Interferometric Synthetic Aperture Radar (InSAR) informs issues related to drought. This type of understanding can empower students to create potential solutions for these "in-the-news" challenges.

Instrumentation

The following overview highlights key technologies and issues studied in geophysics, providing detailed instrument descriptions to help teachers connect them to subject concepts and NGSS. Since many teachers may be unfamiliar with these technologies, the focus of this article is to describe key tools used in geophysics rather than earth science or physics concepts. Geophysics relies on a wide range of instruments to address challenges measuring time scales from fractions of a second to billions of years and distances from microscopic to thousands of kilometers.

The partial list of instruments below is organized into two categories: ground sensors and electromagnetics. These tools are often used in various combinations with complementary methodologies. As you explore these descriptions, consider how the tools align with concepts you teach or refer to the accompanying tables that show connections between instruments, wave properties, and NGSS alignment. Links in this article lead to more in-depth explanations, research, videos, and activities; this article can also be accessed by searching the article's title at www.earthscope.org under Education.

Ground motion and ground position sensors

Seismometers and **Geophones** record ground vibrations which are converted into voltage. These signals are then used to detect and analyze seismic waves traveling through Earth. The waves can have natural sources like earthquakes or detect human activities such as hydraulic fracturing, construction, traffic, and even 'beast-quakes' caused by crowd and music noise at large stadium events. They aid in understanding natural features like subsurface structures, the deep earth, earthquakes, and even surprising things like sea ice coverage and sediment transport in rivers.

Distributed Acoustic Sensing (DAS) systems send infrared laser light through fiber optic cables; within the cable, the light scatters, reflects, or changes speed. It measures how the light changes when the cables are disturbed by vibrations, temperature shifts, or tiny ground movements. DAS can record a broader range of signal frequencies and yields much more data than individual seismometers since each point of the cable can act as a more sensitive sensor. DAS data help scientists understand the environmental impacts from earthquakes, landslides, glacier movements, ships passing by, and even marine life.

Global Positioning System (GPS) uses radio waves sent by satellites to tell us where a receiver is located on Earth; the longer wavelengths of radio waves makes them ideal for traveling long distances and through obstacles like clouds and rain. Receivers (ex. smart phone, car, or precision surveying equipment) determine location by measuring the time offset from when a signal leaves the satellite until it reaches the receiver. Once it detects transmissions from four or more satellites, it calculates the intersection point, its location. GPS tracks changes in the Earth's surface, including tectonic plate motion. It also monitors glacier mass and movement, groundwater levels, and assists in monitoring deforestation, urban growth, and even hurricanes. GPS is one system within the Global Navigation Satellite Systems (GNSS).

Light Detection and Ranging (Lidar) techniques use the time it takes for laser pulses to reflect off surfaces to measure precise distances. Lidar produces accurate 3D maps of land, coastal topography and bathymetry, and tracks areas of flooding through sedimentation rates, deforestation, and atmospheric conditions. Topographic lidar uses near-infrared light, while bathymetric lidar uses green light. Lidar is capable of scanning through vegetation, so it can produce bare-surface maps which can show previously hidden features of Earth's surface.

Interferometric Synthetic Aperture Radar (InSAR) sends microwave signals that reflect off of the Earth's surface and are received by the satellite's sensor recording the wave phase, a point on the wave. InSAR measures land surface changes, like earthquake fractures or changes in stream or river paths, occurring over days or years by comparing images taken from multiple passes over the same location. The phase difference between images measures centimeter to meter-level changes in the ground position. This data helps scientists study earthquake deformation, glacier movement, ground subsidence (ex. due to lowered groundwater levels), landslides, and other environmental changes.

Electromagnetic probes

Electrical Resistivity Tomography (ERT) measures variations in Earth's shallow subsurface by about 100 m within the Earth by applying an electric current between an array of electrodes placed across ground surface or in a borehole. Different types of materials have different resistivities/conductivities. Depending on the array configuration, this instrument can detect and help map groundwater depth, pollution plumes, different minerals or metals, boundaries between subsurface strata and/or structures, and even leaks or weak zones in dams and levees.

Magnetotellurics (MT) uses Earth's natural magnetic and electric fields caused by solar winds and lightning storms to study subsurface electrical resistivity. By measuring variations in both fields, scientists create maps of underground structures as much as 50 km within the earth to reveal information about rock types, fluids, and geological activity. The depth that the electromagnetic signal penetrates into Earth depends on its frequency; the lower the frequency, the deeper the signal, which can be several tens of kilometers or more. With this method, scientists can explore composition, grain size, porosity, permeability, and even monitor groundwater.

Ground Penetrating Radar (GPR) transmits high-frequency radio waves into the ground and measures the reflected signals. These reflections occur when waves encounter subsurface materials with different electrical properties, such as soil, rock, water, or ice (Davis & Annan, 1989). The frequency used and the subsurface properties determine the depth that can be imaged, which can be as deep as about 30 meters in rock and several kilometers through ice. At these shallow depths, GPR has the highest resolution of the techniques discussed here. It is also critical for engineering and forensic studies as it can reveal tree root structures, buried pipes, or even buried human remains. GPR is particularly valuable for environmental studies because it maps underground features, detects water and salinity content, and analyzes permafrost and ice layers.

Gravity Recovery and Climate Experiment (GRACE) includes a series of ongoing satellite-based NASA missions to measure tiny variations in Earth's gravitational field with a focus on understanding environmental and climate processes and monitoring water sources on Earth. GRACE uses microwaves to measure the distance between its two satellites which follow each other as they fly over Earth. Gravity is not constant over Earth's surface; changes in mass, such as melting glaciers, groundwater changes, and tectonic movements among others, lead to changes in the gravitational field. These variations affect the satellites' speeds. Because one satellite will be affected by a gravity difference before the other, there will be a change in the distance between them. This change in distance is used to determine gravity levels at that location and scientists can gain insight into sea-level rise, water resource management, shifts in Earth's ecosystems, and other critical issues.

Classroom Integration

The applications for these methods have expanded and use has accelerated in the last 20 years, with some applications emerging only in the last five years. While educational resources are becoming available for undergraduate and graduate learners, there are still very few designed for students in grades 6-12. This article aims to raise awareness about the field of geophysics and the tools used by geophysicists. These tools play a crucial role in studying critical environmental topics as well as landslides, earthquakes, and other natural and human-induced hazards; they can be integrated into the curriculum to give students added context for a deeper understanding of the issues and concepts.

The tables below connect the instruments with the environmental issues they help scientists study, the physics concepts and corresponding NGSS Performance Expectations (PEs). How can you use these tables? It depends on what you are planning your curriculum around: will students be exploring an environmental issue, focusing on a physics concept, or completing a PE? Here's one example, although this is by no means the only way to use them.

Scenario:

My high school students are studying waves and wave behaviors in my physics class. Instead of jumping from one concept to the next without context to make it more relevant, I want to connect these concepts to a current-in-the-news topic students will be motivated to learn about. Once I identify the connection, I can begin planning my unit and determining the NGSS standards it will support.

- I Look at Table 2 since I'm starting the unit with wave characteristics, I look at Table 2 which connects science content about wave behaviors to geophysical tools. In this table I determine that I can connect to the Wave Properties column through wavelengths using the electromagnetic spectrum since GPS uses longer radio waves and InSAR uses microwaves, specific wavelengths within the radio wave range, to measure wave phases and shifts. I bring in wave speed (velocity) and frequency for both instruments and the law of reflection for InSAR.
- Looking at Table 3, within this unit on waves, I can include all the performance expectations listed except for HS-ESS2-3 for this unit on waves. I'm going to focus on groundwater since I'm in California. Groundwater depletion in the Central Valley, driven by drought and increased pumping for agriculture and population growth, is causing subsidence. *Note: Choose a topic related to a local issue to increase relevance.*
- Just to make sure, I look at Table 1, and confirm that both instruments are used in groundwater studies.

- I can also integrate HS-PS4-2 from Table 4 on how digitized signals transmit more reliable signals than analog methods.

Now that we have the connections, how does this all go together when teaching? Here is the beginning of one idea (remember, there are many different approaches to teaching these topics):

- **Engage:** Introduce the issue or the situation.
  - Bring in a video, before and after images, or a headline and start a discussion about the drought
    - Ask students how the drought has affected them.
    - Ask students to find out how the residents in Calfiornia's Centra Valley have been affected by subsidence.
  - Bring in the idea of groundwater
    - Use data to support the idea of the subsidence of California's Central Valley
    - Then, bring in the idea of why we can trust the data.
- **Explore/Explain:** How do we measure groundwater levels?
  - Discuss the instruments -
    - How do they work? Use the animation Measuring Drought (UNAVCO, 2016).
      - We measure changes in ground surface elevation but how does GPS do this?
      - Integrate key physics concepts on waves.
      - What is a wave?

Explore what may seem like a tangent, as long as you tie it back to your main topic or theme. For instance, in discussing drought, consider where wave speed can be used —GPS measures elevation by tracking how long it takes for a radio wave (concepts to include: wavelength and the electromagnetic spectrum) to travel from the satellite and then calculating the distance which allows you to bring in wave speed. Have students analyze real data. Differences in elevation over time show subsidence. You can even introduce the idea of strata when talking about where the groundwater is. Why are these connections important for students? It provides real-world applications of scientific concepts and practices, reinforcing that science is not just theoretical but actively explains phenomena they experience in their lives. (*USGS. Groundwater Availability of the Central Valley Aquifer, California)*

As you develop your unit or module, ensure integration of the **NGSS**. Ask yourself:

- Where have I incorporated relevant **Physics and/or Earth Science Performance Expectations (PEs)** or **Disciplinary Core Ideas (DCIs)?**
- Have I included **Crosscutting Concepts (CCCs)?**
- Am I using **evidence statements** from the NGSS links in the tables below to verify alignment?

If any of these elements are missing, consider where and how they can be integrated. Don't forget the **Science and Engineering Practices (SEPs)**—for example, where can students construct explanations using valid and reliable evidence? The PHET simulations linked in Table 2 can support students in explaining wave behavior. Ask yourself, "how have I made the DCIs, SEPs, and CCCs explicit to my students so they understand which NGSS dimensions they are using and recognize that they are doing real science.

If another tangent arises, use it to introduce additional Earth Science connections. Table 1 shows that GPS not only helps geophysicists study groundwater levels but also monitors **Geohazards**. This opens opportunities to discuss **forces and how earthquakes are measured** and/or the **conversion of potential to kinetic energy**.

You can always circle back to the original topic. Linking science concepts to a relevant topic whenever the situation allows, makes the most of your time by bundling PEs and DCIs.

Ultimately, these topics help students understand **wave characteristics and behavior** within a **relevant, place-based issue—the California drought**—bridging physics concepts with real-world challenges that matter to them. **All colored text and shapes** in the tables below are linked to additional resources.

Table 1. Connections Between Tools and Environmental and Earth Science Topics

Connecting geophysical tools used to study Earth's global issues and the classroom. Circles and underlined text provide background information for the educator, linking the tool to the topic through research papers, videos, readings, or websites. Triangles lead to educational resources for classroom use, including activities, videos/animations, and readings; there are a few with links to two resources. It is important to note that some educational resources may focus on a fundamental understanding of either the tool or the topic.

	Earth's Inner Structure	Glacial Change	Geohazards	Flood & Water Monitoring	Vegetation & Soil Moisture	Sea-Level Change	Atmospheric Studies
	Seismic activity is used to determine Earth's structure.	Tracking glacial mass and/or velocity change.	Earthquake, volcano, tsunami, and landslide hazards.	Groundwater movement and flood hazard	Monitors changes in forest canopy, vegetation thickness, and soil moisture.	Measures shifts in ocean levels that can be linked to climate change or tectonics.	Monitors atmospheric water vapor, air quality, and weather patterns.
Seismic Sensors (eg, DAS, seismometer)	● ▲	● ▲	● ▲	● ▲			
GPS		● ▲	● ▲	● ▲	● ▲	● ▲	● ▲
Lidar		● ▲	● ▲	● ▲	● ▲	● ▲	● ▲
InSAR		● ▲	● ▲	● ▲	● ▲		● ▲
Electric & Electro-Magnetic methods (ERT, MT, GPR)	● ▲ ▲	● ▲ ▲	● ▲ ▲	● ▲ ▲	● ▲ ▲		
Gravity Techniques (eg. GRACE)		● ▲ ▲		● ▲	● ▲	● ▲	● ▲

● Background info: it will link the tool with the topic. ▲ Education resource that is related to the topic

Table 2. Connections Between Wave Behaviors and Tools

Connecting geophysical tools related to relevant wave behaviors and characteristics to the classroom. Circles provide background information for the educator. Green circles in the column headings give you or your students background on the wave characteristics while the colored circles within the table body like the tool to the concept through videos, readings, or websites. Triangles lead to educational resources for classroom use on the general wave topics only and, include activities, videos/animations, and simulations.

	Attenuation ● ▲	Interference ● ▲	Reflection ● ▲	Refraction ● ▲	Scattering ● ▲	Wave Properties ● ▲	Fields ● ▲
	Reduction in wave energy as it travels through materials, used to infer properties of subsurface layers.	Overlapping waves are used to measure minute changes in distances or fields.	Measures the return of waves after hitting surfaces.	Waves bend when passing through different materials.	Waves interact with particles, spreading energy.	Variations in wave speed, amplitude, wavelength, frequency, reveal material properties, like density or water content.	Variations in electrical resistivity or changes in field properties reveal material properties like density and fluidity.
Seismic Sensors (seismometers)						Seismic wave, Amplitude, Frequency, and Speed.	
DAS			●	●	●	Wave speed, Amplitude, Frequency	
GPS			●			Wave speed, Doppler effect (red shift)	
Lidar			●		●	Wave speed	
InSAR		●	●			Wave phase, Wave speed	
Electrical and Electro-Magnetic methods							Electrical resistivity reveals subsurface structures and ground water
GPR	●		●		●	Wave speed, Amplitude	
Gravity Techniques						Wave speed	Gravitational field revealed by density differences.

● Background info: it will link the tool with the topic. ▲ Education resource that is related to the topic

Table 3. High School NGSS: Earth & Space Science

Connections between geophysical tools and High school NGSS Earth and Space Science Performance Expectations. (Find Middle school ESS-PEs under this article's title at earthscope.org under Education.) There may be more possible connections. NGSS landing pages include links to evidence statements and example bundles.

	HS-ESS2-2	HS-ESS2-3	HS-ESS2-5	HS-ESS3-1	HS-ESS3-4	HS-ESS3-5
	Analyze geoscience data to understand Earth's systems and feedback loops.	*Develop models of Earth's interior to explain material cycling.*	*Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.*	*Construct evidence-based explanations for natural resources and hazards' impacts.*	*Evaluate technologies that mitigate human impacts on natural systems.*	*Analyze geoscience and global climate data to forecast current rate of climate change and future impacts.*
Seismic Sensors (seismometers, DAS)	Tectonics Surface movement	Tectonic processes	Groundwater monitoring	Volcanic and tectonic hazards and human impact (detection of drilling, ships, etc.)	Explosions, fracking, urban noise, pipeline monitoring, and carbon storage.	Glacier monitoring
GPS	Surface movement and tectonics		Atmospheric studies	Volcanic and tectonic hazards, monitoring glaciers, and drought studies	Drought studies	Atmospheric studies, drought studies, glacier monitoring and sea level changes
Lidar	Surface movement (landslides)		Flood risk	Deforestation and floods	Pollution levels and deforestation (forest canopy height)	Glacier monitoring and sea level changes
InSAR	Surface movement and tectonics		Groundwater monitoring	Changes in landscape from hazards	Groundwater, glacier monitoring, and sea level change	Glacier monitoring and sea level change
EM methods (ERT, MT)	Tectonics		Groundwater monitoring	Resource distribution • water distribution	Groundwater, leachates and contaminants	Groundwater monitoring
GPR	Subsurface features		Groundwater monitoring	Resource distribution • water distribution and abrupt changes to subsurface structures	Buried tanks or other metals	Groundwater monitoring
Gravity Techniques (eg, GRACE)	Mass distribution		Groundwater levels and total water storage (ice, surface water, sea level and ocean currents)	Resource distribution • water distribution and abrupt changes to subsurface structures	Total water storage (groundwater, ice, surface water, sea level and ocean currents)	Glacier monitoring and causes of sea level changes

Table 4. High School NGSS: Physics

Connections between geophysical Tools and High school level NGSS- Physics Performance Expectations. (Find Middle school ESS-PEs under this article's title at earthscope.org under Tools.) There may be more possible connections. NGSS landing pages include links to evidence statements and example bundles.

	HS-PS2-5	HS-PS4-1	HS-PS4-2	HS-PS4-5
	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	Use mathematical representations to explore relationships among frequency, wavelength, and speed.	Evaluate questions about the advantages of using digital transmission and storage of information.	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
Seismic Sensors (seismometers)		Wave speed, frequency, wavelength	[**Clarification Statement:** Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] *Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.* Refer to MS-PS4-3 for more.	Seismometers record seismic wave arrival times.
DAS				Wave phase from backscatter is determined.
GPS				Radio waves are transmitted by satellites.
Lidar				Infrared waves reflect off surfaces for wave phase.
InSAR				Microwaves reflect off surfaces for phase shift comparisons.
Electrical and EM methods (ERT, MT)	Magnetic fields induce electric currents	Signal frequencies (with variations in depth – **higher** level math required)		
GPR		Speed depends on subsurface content.		Radio waves reflect off subsurface structures.
Gravity Techniques (eg, GRACE)				

NGSS landing pages include links to evidence statements and example bundles.

In addition to the links in the tables above, the following EarthScope resource includes lessons integrating these instruments with environmental issues and features analysis of real data collected by the instrument - GETSI: Geophysics Tools for Societal Issues. While the lessons are designed for college-level students, many are easily adaptable to fit secondary students. Also explore the Geophysics and Seismology Resources site which provides a range of educational resources including lessons, animations, webtools, and more.

Ultimately, incorporating geophysics into Physics or Earth Science classrooms will not only enrich the concepts taught in those disciplines but also empower students to see how scientific inquiry is essential for addressing today's global challenges. This interdisciplinary approach encourages students to see science not as isolated subjects, but as interconnected tools for deeper understanding— equipping them to potentially solve the complex problems facing our planet.

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References

Boatman, L. (2023, Jun 15). *As Undergrad Physics Enrollment Stumbles, Departments Look Inward.* APS125. https://www.aps.org/apsnews/2023/06/undergrad-enrollment-stumbles

Davis, J.L., & Annan, A.P. (1989). *Ground-penetrating radar for high-resolution mapping of soil and rock stratigraphy.* Geophysical Prospecting, 37(5), 531-551.

Gwynne, P. (2024, Sep 11). *Almost 70% of US students with an interest in physics leave the subject, finds survey.* Physicsworld.

Johansen, M.O., Eliassen, S., and Jeno, L.M. (2023, Sept 27). *"Why is this relevant for me?": increasing content relevance enhances student motivation and vitality.* Frontiers in Psychology.

Keane, C. (2022, Nov 21). *U.S. Geoscience Enrollments and Degrees through 2021.* American Geosciences Institute.

Keblbeck, D., Piatek-Jimenez, K., and Medina-Medina, C. (2024, Sept. 27). *Undergraduate physics students' experiences: Exploring the impact of underrepresented identities and intersectionality.* American Physical Society.

National Research Council (2013), *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press. https://doi.org/10.17226/18290

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