TEACHERS GUIDE

LESSON 1 — UNDERSTANDING EARTH'S CHANGING CLIMATE

Weather vs. Climate

Begin by discussing the differences between weather and climate, emphasizing that weather refers to short-term atmospheric conditions while climate refers to long-term patterns. Use relatable examples and visuals to illustrate these concepts. For example, explain that weather is what we experience day-to-day, like a sunny afternoon or a rainy morning. In contrast, climate is the average of these weather patterns over many years, such as the typically hot and dry summers in Arizona. Helping students grasp this distinction sets the foundation for understanding broader environmental changes.

Global Warming vs. Climate Change

Next, clarify the distinction between climate change and global warming, highlighting that global warming is a component of climate change but not synonymous with it. Explain that global warming refers specifically to the Earth's rising surface temperatures due to increased greenhouse gas emissions. Climate change encompasses global warming and includes other changes like shifts in precipitation patterns, more extreme weather events, and rising sea levels. Use evidence and examples to show how global warming contributes to these broader climate changes, making the concepts more tangible for students.

Investigative Processes for Studying Climate Change

Engage students in a brainstorming session to generate ideas about how scientists study climate change. Encourage them to consider various methods such as ice core analysis, satellite observations, and computer modeling. Provide opportunities for students to share their ideas with the class and discuss the strengths and limitations of different investigative approaches.

Human Activity as the Main Driver of Climate Change

Explain the scientific consensus that human activities, particularly the burning of fossil fuels and deforestation, are primary drivers of climate change. Use evidence from scientific research to support this assertion, such as trends in greenhouse gas emissions and temperature records. Encourage critical thinking by prompting students to analyze the rationale behind scientists' conclusions.

Graphical Representations of Climate Change Data

Introduce students to graphical representations of climate change data, such as temperature graphs, precipitation maps, and ice core records. Teach them how to interpret these graphs by identifying trends, patterns, and anomalies. Encourage students to analyze graphical data critically and draw conclusions about the impacts of climate change based on the evidence presented.

LESSON 2

INVESTIGATING CLIMATE CHANGE

Greenhouse Effect

Start by explaining the greenhouse effect using simple language and analogies to help students grasp the concept. Use visuals such as diagrams or animations to illustrate how greenhouse gases trap heat in the Earth's atmosphere, creating a warming effect similar to a greenhouse.

Carbon Cycle

Break down the carbon cycle into its components, emphasizing the movement of carbon through different reservoirs such as the atmosphere, oceans, and living organisms. Use real-life examples to demonstrate how carbon moves between these reservoirs and highlight the role of human activities in altering the carbon cycle.

Greenhouse Gases

Provide a list of common greenhouse gases, including carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. Explain how these gases contribute to the greenhouse effect and climate change by trapping heat in the Earth's atmosphere. Encourage students to identify sources and impacts of each greenhouse gas.

Human Activities vs. Natural Causes

Differentiate between human activities, such as burning fossil fuels and deforestation, and natural causes, such as volcanic eruptions and changes in solar radiation, that contribute to climate change. Use examples and case studies to illustrate the relative contributions of human and natural factors to greenhouse gas emissions and global warming.

Climate Change Indicators

Introduce students to climate change indicators as measurable observations or calculations that track changes in environmental conditions over time. Provide examples of common indicators, such as changes in temperature, precipitation patterns, sea level rise, and glacier retreat, and explain how these indicators are used by scientists to monitor climate change impacts.

Carbon Footprint

Define carbon footprint as the total amount of greenhouse gases, particularly carbon dioxide, emitted directly or indirectly by human activities. Discuss how individual actions, such as energy consumption, transportation choices, and dietary habits, contribute to carbon emissions and climate change. Encourage students to calculate their carbon footprint using online calculators and explore ways to reduce it.

Climate Data Research Methods

Introduce students to various methods used by scientists to study climate change, such as ice core analysis, tree ring analysis, satellite observations, and computer modeling. Explain how each method provides valuable insights into past and present climate conditions and helps researchers understand the causes and effects of climate change.

LESSON 3 — HOW CLIMATE CHANGE IMPACTS THE NATURAL WORLD

Climate Change and Extreme Weather

This concept refers to the correlation between shifts in global climate patterns and severe weather events like hurricanes, droughts, and heat waves. Engage students by discussing real-world examples of extreme weather events linked to climate change. Encourage critical analysis and discussions about impacts on communities and ecosystems using multimedia resources and case studies.

Rising Sea Levels and Melting Ice

This phenomenon involves the gradual increase in global sea levels due to the melting of polar ice caps and glaciers, threatening coastal communities and ecosystems. Use visual aids like maps and satellite images to illustrate rising sea levels and melting ice. Relate local impacts to broader climate change trends to emphasize the urgency of the issue and inspire exploration of solutions through inquiry-based learning.

Phenology and Climate Change

Phenology studies seasonal changes in plant and animal life cycles related to climate variability. Engage students by conducting outdoor observations and participating in citizen science projects. Some great places to find active citizen science projects online include SciStarter, iNaturalist, GLOBE Observer, Nature's Notebook, and Budburst. These experiences provide hands-on opportunities for students to explore connections with biology and environmental science while deeping their understanding and inspiring environmental stewardship.

Animal Migration and Climate Change

Changes in climate influence animal migration patterns, leading to ecological disruptions. Investigate case studies and use multimedia resources to explore these complexities. Encourage critical analysis of ecological consequences and human impacts, empowering students to advocate for conservation efforts.

IMPACTS OF CLIMATE CHANGE ON EARTH'S ECOSYSTEMS

Climate Change Impacts on Ecosystems

It's crucial to convey the interconnectedness of ecosystems and their susceptibility to climate change. By understanding how changes in temperature, precipitation, and acidity affect biodiversity, ecosystem health, and ecosystem services, students gain insight into the intricate balance of nature and the profound implications of climate change on Earth's ecosystems.

Ocean Acidification

Delve into the process of ocean acidification caused by increased carbon dioxide levels. This phenomenon alters ocean chemistry, posing significant threats to marine life and coral reefs. Utilizing engaging demonstrations like the chalk-and-vinegar experiment, students grasp the tangible effects of ocean acidification and its potential repercussions on marine ecosystems.

Biodiversity Loss

Use coral reefs as a case study to illustrate the devastating impacts of climate change on biodiversity within ecosystems. By examining coral bleaching and the proliferation of invasive species, students uncover the intricate web of interactions within ecosystems and comprehend the cascading effects of biodiversity loss on ecosystem stability and resilience.

Ecosystem Services

Explore the concept of ecosystem services and how climate change disrupts these vital functions. From providing clean water and air to supporting food production and regulating climate, ecosystems offer invaluable services to human societies. By identifying examples of disrupted ecosystem services, students recognize the far-reaching consequences of ecosystem degradation on human well-being and economies.

Mitigation and Restoration Efforts

Empower students to take proactive steps in mitigating climate change impacts and restoring ecosystems. By discussing strategies such as oyster gardens and reforestation initiatives, students gain a sense of agency in combating climate change and preserving biodiversity. Encourage critical thinking about the effectiveness and scalability of these efforts, fostering a deeper understanding of the complexities involved in addressing climate change challenges.

LESSON 5

HOW CLIMATE CHANGE IMPACTS HUMAN QUALITY OF LIFE

Climate Change Impacts on Human Quality of Life

Emphasize the essential needs of humans, such as food security, clean air and water, shelter, safety, employment, community, and cultural practices, and illustrate how climate change affects each aspect. Use real-world examples and case studies like agriculture and the built environment to make the concept tangible for students. Encourage interactive discussions and group activities to deepen understanding.

Disproportionate Impact on Communities

Facilitate conversations about how climate change disproportionately affects different communities, particularly low-income and BIPOC communities. Encourage students to analyze case studies and propose solutions-oriented actions to address these disparities. Provide resources and guidance to help students explore diverse perspectives and develop empathy toward marginalized groups.

Urban Heat Islands and Extreme Weather Events

Introduce students to concepts like urban heat islands and their effects on cities, as well as the role of infrastructure in determining community resilience to extreme weather events. Utilize multimedia resources, such as videos and interactive simulations, to engage students and enhance understanding. Encourage hands-on activities, such as mapping exercises and field trips, to help students visualize and experience these phenomena firsthand.

Mitigation and Adaptation Strategies

Empower students to take action by researching and proposing mitigation and adaptation strategies for extreme weather events and other climate change impacts. Provide guidance on how to create effective public service announcements that raise awareness and inspire community action. Encourage creativity and critical thinking in developing solutions-oriented projects, and provide opportunities for peer collaboration and feedback.

THE IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH

Identifying Health Hazards

This involves recognizing the various threats to human health posed by climate change, such as increased frequency and intensity of extreme weather events, air pollution, changes in water quality and availability, spread of vector-borne diseases, food insecurity, and impacts on mental health.

Understanding Vulnerability

Vulnerability refers to the susceptibility of individuals or communities to the adverse effects of climate change. Factors contributing to vulnerability include socioeconomic status, access to resources, geographic location, age, gender, health status, and social networks. Understanding vulnerability helps inform strategies for adaptation and resilience-building.

Climate Drivers

A climate driver is a factor or mechanism that influences the Earth's climate system, causing it to change. Examples of climate drivers include variations in solar radiation, greenhouse gas emissions, volcanic eruptions, and changes in ocean currents and atmospheric circulation patterns.

Environmental Conditions

Environmental conditions refer to the state or quality of the natural environment, including air, water, soil, and ecosystems. Changes in environmental conditions, such as increasing temperatures, shifts in precipitation patterns, and alterations in biodiversity, can have profound impacts on human health and well-being.

Environmental Hazards

An environmental hazard is any agent or factor in the environment that poses a threat to human health or the environment itself. These hazards can include chemical pollutants, biological pathogens, physical stressors (e.g., extreme temperatures, natural disasters), and social factors (e.g., poverty, conflict) exacerbated by climate change.

Exposure Pathways

An exposure pathway is the route or mechanism through which individuals or populations come into contact with environmental hazards. This can include inhalation of polluted air, consumption of contaminated food or water, direct contact with hazardous substances, or exposure through social and economic factors. Understanding exposure pathways is crucial for assessing and mitigating health risks associated with climate change.

Climate Change and Human Health

Climate change has significant implications for human health and health outcomes, including heat-related illnesses, respiratory diseases, waterborne illnesses, malnutrition, mental health disorders, and the spread of infectious diseases. Understanding the complex interactions between climate change and human health is essential for developing effective adaptation and mitigation strategies.

LESSON 7 — HOW CLIMATE CHANGE AFFECTS DIFFERENT REGIONS OF THE UNITED STATES

Regional Variation in Climate Change Impacts

Begin by explaining to students that climate change and its impacts can vary greatly depending on where you live. Some places will warm faster than others, some will receive more or less rainfall, and some will experience flooding or sea level rise while others will experience drought and a greater chance of wildfires. Watch the provided videos and engage students in questions that get them thinking about how climate change impacts different regions of the United States and why these regional variations are important.

Drivers and Impacts of Climate Change

Guide students to comprehend the primary drivers of climate change and how they specifically impact the environment, people, built infrastructure, and human health within their region. Give them time to read and discuss the articles in pairs. Transfer some of that knowledge to think about their local community. Encourage students to delve into the scientific understanding of these drivers and their implications for local ecosystems and communities.

Local Mitigation and Action

Encourage students to apply their learning to their local context by identifying climate change issues relevant to their community. Through reflection and discussion with their families, students should recognize the potential impacts of climate change on aspects such as air quality, food security, infrastructure, and overall quality of life. Additionally, prompt students to consider personal and collective actions they can take to address these issues and contribute to climate resilience efforts in their region, including writing to a local official.

LESSON 8 — EXPLORING CLIMATE JUSTICE CAREERS

Diverse Green Careers

Green careers refer to occupations and professions that contribute to environmental sustainability, conservation, and the mitigation of climate change. Introduce students to the concept of green careers and climate justice by showcasing a variety of career paths related to addressing climate change. Encourage students to explore the videos and engage in discussions to broaden their understanding of the diverse opportunities available in this field. Conduct a mini career fair where students can display what they have learned about green careers.

Motivations of Green Careers

Highlight motivations of green careers such as meaningful work, innovation and creativity, and job security and growth. With increasing global awareness of environmental issues and the transition toward a low-carbon economy, green careers are projected to experience growth and demand and can offer job security and advancement opportunities.

Challenges of Green Careers

Discuss the reality of challenges in green careers, which include lack of awareness and education, navigating complex policy and regulatory environments, and addressing climate change skepticism and resistance. Green careers often intersect with complex policy and regulatory environments related to environmental protection, energy transition, and climate change mitigation. Have students discover more about diverse green careers by researching a green career and completing the career brochure worksheet.

LESSON 9 — HOW CLIMATE CHANGE IMPACTS YOUR COMMUNITY

Sustainable Development Goals

The United Nations Sustainable Development Goals (SDGs) provide a framework to guide policy, priorities, and investments to address global challenges. Utilize linked resources (articles and videos) to introduce students to the SDGs and their relevance to local communities. Help students understand the scope of the SDGs, which encompass a wide range of global issues, including climate action, poverty alleviation, and access to clean water and sanitation.

Climate Change and SDGs

Guide students in exploring the connections between climate change issues and specific SDGs. Encourage them to identify local climate change impacts and brainstorm which SDGs are most relevant to their community. Facilitate discussions that highlight the interconnectedness of climate change with other social, economical, and environmental challenges addressed by the SDGs.

Project Pitches

Guide students through the process of creating a pitch for a project that addresses a local climate change issue. Encourage students to collect data on their chosen SDG, identify community stakeholders they can talk to and gather information from, and outline specific actions they can take in support of their proposed project.

LESSON 10

CLIMATE CHANGE SOLUTIONS: TAKING ACTION IN YOUR COMMUNITY

Innovative Climate Change Solutions

Discuss various innovative solutions addressing climate change, such as shading crops with solar panels and using carbon dioxide–infused cement. The short video on Kernza provides students with an example of an innovative climate change solution. Students will analyze these solutions and consider how they play a role in lessening the impacts of climate change and addressing the SDGs.

Climate Ambassadors

Explain to students that climate ambassadors are individuals, often young people, who take on a leadership role in advocating for climate action and promoting environmental stewardship within their community or broader society. They may engage in a variety of activities, such as organizing events, raising awareness about environmental issues, promoting sustainable practices, lobbying policymakers, and participating in community initiatives aimed at mitigating climate change. Watch the video, and facilitate a discussion with students about how their project proposal will allow them to become climate ambassadors in their own community.

Project Proposals

Lead students in developing their project proposals, based on feedback they received on their project pitches. Allow them time to create oral or visual presentations that describe their project proposals, including which climate change issue is addressed and the reason for its selection, the issue's relevance to their chosen SDG, and goals for implementing the project in their community. Conclude with an evaluation of the students' project proposals and a vote among students of which project proposal has the most potential for effectively combating climate change in their community.