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MODULE 3

environment and air

trainer's booklet

raise awareness about global warming, climate change, the greenhouse effect, and sea level rise.

IDEA Universal (Turkey)
DUTH (Greece)
UABSC (Ukraine)
İO-BAS (Bulgaria)

ENVIRONMENT AND AIR

NO	ACTIVITIES	STATUS
1	The Frightening Rise in Sea Levels!	120 minutes
2	Let's Measure Our Air Quality!	120 minutes

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THE FRIGHTENING RISE IN SEA LEVELS!

Ages 8-15

Environment and Air

120 minutes

Key Concepts

- Climate Change
- Global Warming
- Greenhouse Gases
- Carbon Emissions
- Renewable Energy
- Energy Efficiency
- Sustainability

Purpose: In this activity, it is aimed for students to raise awareness of the impacts of climate change, to explore solutions for global warming through a climate solutions simulator, and to enhance their skills in applying STEM-based approaches to analyze data, predict outcomes, and develop collaborative solutions.

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Learning Outcomes

By the end of this activity, students will be able to:

- Define key concepts related to climate change, (e.g., global warming, carbon emissions, and renewable energy.
- Analyze the relationship between human activities and rising global temperatures using a climate solutions simulator.
- Test and evaluate the effectiveness of various climate policies and technological solutions.
- Develop and present a comprehensive action plan to limit global temperature rise.
- Enhance collaborative problem-solving and critical thinking skills.

Materials

Tablets with Internet access, En-ROADS Climate Solutions Simulator: https://www.climateinteractive.org/en-roads/, worksheets, markers and pencils.

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EDUCATOR GUIDELINES

1- Introduction (15 minutes)

- Begin by discussing the importance of climate change and its impacts using real-world examples.
- Ask the following questions to engage students:

o What are the main causes of climate change?
o How do CO_2 emissions contribute to global warming and sea level rise?
o What solutions have you heard about to combat climate change?

- Provide a short demonstration of the En-ROADS simulator, explaining its features and how different policies can affect global temperature, emissions, and energy use. Highlight the connection between policy choices and sea level rise.

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2- Policy Testing and Data Collection (35 minutes)

- *Divide students into teams of three to five members and assign each team a stakeholder role (e.g., government, industry, environmental NGOs).*
- *Encourage teams to prioritize their goals, such as significantly reducing emissions to slow global warming, developing solutions to mitigate the impacts of sea level rise on coastal areas, or ensuring economic growth while adopting sustainable practices.*
- *Each team selects specific policies to test, such as:*

o Transitioning to renewable energy sources.
o Implementing carbon pricing mechanisms.
o Promoting afforestation to absorb CO_2 .
o Enhancing energy efficiency in various sectors.

- Use the En-ROADS simulator to predict the outcomes of their selected policies on global temperature, CO_2 emissions, and sea level rise.
- Record results on worksheets, focusing on:

o Changes in key metrics like temperature and emissions.
o Observations about the effectiveness of tested policies.

- Teams document the trade-offs, challenges, and co-benefits observed during their simulations.

3- Analysis and Discussion (30 minutes)

- *Teams present their findings and discuss the trade-offs observed during policy testing.*
- *Facilitate a discussion using questions such as:*

o Which policies were most effective in reducing CO_2 emissions and sea level rise?
o What challenges did you encounter while balancing environmental and economic goals?

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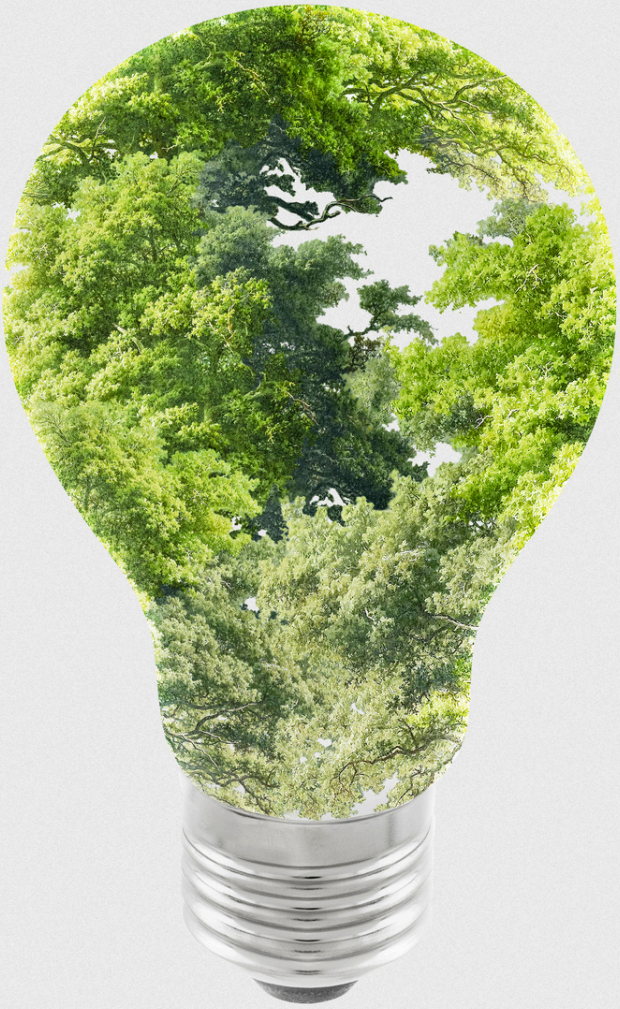

4- Action Plan Development (25 minutes)

- *Ensure that teams develop a joint action plan using the En-ROADS simulator to keep global temperatures below 2°C by 2100 and mitigate sea level rise. Throughout this process, encourage students to refine their action plans and maintain a balance between environmental, social, and economic goals.*

5- Reflection and Conclusion (15 minutes)

- *Ask reflective questions:*

o What surprised you the most about the simulation?

o What lessons can we apply to real-world climate actions?

- *Summarize key takeaways and emphasize the importance of collaborative problem-solving in addressing global challenges.*

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BACKGROUND

CO_2 Emissions

Carbon dioxide (CO_2) is the most common greenhouse gas released into the atmosphere due to the combustion of fossil fuels such as coal, oil, and natural gas, as well as deforestation and industrial activities. Since the Industrial Revolution, human activities have significantly increased atmospheric CO_2 levels, leading to a rise in global temperatures.
The primary sources of CO_2 emissions include energy production, transportation, and industrial processes. The use of coal and natural gas for electricity generation, fossil fuel consumption in transportation, and cement, steel, and chemical production in industries result in the release of large amounts of CO_2 into the atmosphere. Additionally, deforestation and land-use changes reduce natural carbon sinks, further exacerbating CO_2 emissions.

Scientists emphasize that reducing CO_2 emissions is crucial for limiting global temperature increases. The transition to renewable energy, implementation of energy efficiency measures, development of carbon capture technologies, and adoption of sustainable land management strategies are key actions necessary to lower carbon emissions.

Greenhouse Effect and Global Warming

A portion of the sunlight reaching Earth is reflected back into space, while most of it is absorbed by the surface. The energy absorbed by the surface is later re emitted as infrared radiation into the atmosphere. Greenhouse gases in the atmosphere trap some of this radiation and redirect it back to Earth. This process, known as the natural greenhouse effect, helps regulate Earth's temperature. Without this effect, the planet's average temperature would be approximately -18°C instead of the current 15°C, making life as we know it impossible.

However, human activities such as fossil fuel consumption, deforestation, industrial operations, and agricultural practices increase the concentration of greenhouse gases in the atmosphere, leading to greater heat retention. This phenomenon, known as the enhanced greenhouse effect, is responsible for rising global temperatures.

The major greenhouse gases in the atmosphere include water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxides

(N_2O), ozone (O_3), and chlorofluorocarbons (CFCs). While stratospheric ozone plays a vital role in protecting life by absorbing harmful ultraviolet (UV) radiation, tropospheric ozone is a pollutant formed by human activities and acts as a short-lived greenhouse gas.

As a result of the enhanced greenhouse effect, increased temperatures in the lower layers of the atmosphere and Earth's surface are collectively referred to as global warming. Global warming directly contributes to climate change, leading to glacier melting, rising sea levels, biodiversity loss, water scarcity, drought, desertification, wildfires, and more frequent and intense extreme weather events.

Since the Industrial Revolution, Earth's average surface temperature has increased by approximately 1°C due to human activities. Scientists stress that in order to prevent irreversible impacts of climate change, global warming must be limited to 1.5°C above pre-industrial levels.

Rising Sea Levels

With climate change, global sea levels continue to rise. Between 1901 and 2018, the average global sea level increased by approximately 20 cm, and this rate is accelerating. While the annual average sea level rise was 2 mm between 1971 and 2006, it increased to 4 mm per year between 2006 and 2018. The two main causes of rising sea levels are thermal expansion of warming ocean waters and the melting of land-based ice sheets and glaciers.

Glaciers are classified into two types: sea ice and land ice. Sea ice, such as that found in the Arctic Ocean, already floats in the water, so its melting does not significantly affect sea levels. However, the melting of land ice, such as the Greenland and Antarctic ice sheets, adds substantial amounts of water to the oceans, causing sea levels to rise—a process comparable to adding more ice cubes to a full glass of water.

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Climate change and glacier melting are self-reinforcing processes. As global temperatures rise, polar regions also warm, leading to increased ice melt. Glaciers and snow cover reflect sunlight, helping to cool the planet. However, when ice melts, it exposes darker land and ocean surfaces that absorb more solar energy, further increasing temperatures. This accelerates ice melt, leading to greater instability in the global climate system.

Renewable Energy

Renewable energy sources such as solar, wind, hydroelectric, geothermal, biomass, wave, and tidal energy offer a sustainable alternative to fossil fuels. Unlike fossil fuels, these energy sources do not produce CO_2 emissions during power generation, making them crucial for mitigating climate change.

Carbon Pricing

Carbon pricing is an economic strategy designed to reduce carbon emissions. The two main approaches are:

- Carbon Tax: A direct fee is imposed on carbon emissions, encouraging a reduction in fossil fuel consumption.
- Cap-and-Trade System: A limit is set on total carbon emissions, allowing businesses to buy and sell emission allowances. This system provides financial incentives for companies to cut emissions in the most cost effective way.

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Energy Efficiency

Energy efficiency refers to using less energy while maintaining the same level of performance. It can be achieved through technological advancements, improvements in industrial practices, and individual energy conservation habits. Enhancing energy efficiency not only reduces emissions but also helps preserve natural resources.

Sustainability

Sustainability aims to meet the needs of the present without compromising the ability of future generations to meet their own needs. This concept integrates environmental protection, economic development, and social justice, promoting the conservation and efficient use of natural resources.

Failure to maintain ecological balance can lead to severe global issues such as biodiversity loss, climate change, water and food shortages. Therefore, sustainable development focuses on preserving ecosystem services, transitioning to renewable energy sources, and promoting a circular economy to ensure long-term environmental stability and human well-being.

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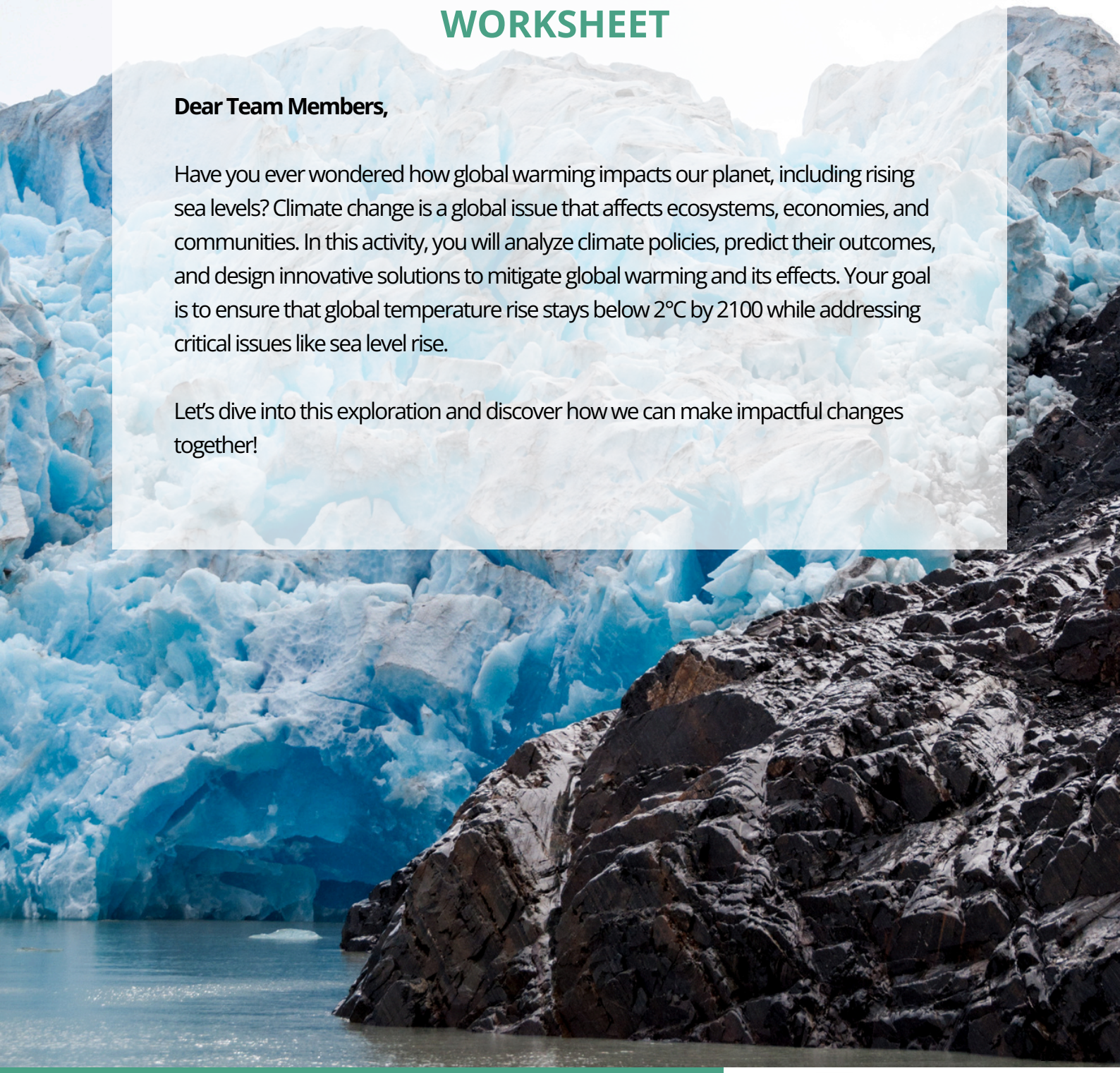
WORKSHEET

Dear Team Members,

Have you ever wondered how global warming impacts our planet, including rising sea levels? Climate change is a global issue that affects ecosystems, economies, and communities. In this activity, you will analyze climate policies, predict their outcomes, and design innovative solutions to mitigate global warming and its effects. Your goal is to ensure that global temperature rise stays below 2°C by 2100 while addressing critical issues like sea level rise.

Let's dive into this exploration and discover how we can make impactful changes together!



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Step 1: Experimental Design

1- Select Policies:

Write down three policies you would like to investigate, along with your reasons for choosing them.

Policy 1	
Reason for Selection	

Policy 2	
Reason for Selection	

Policy 3	
Reason for Selection	

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2- Identify the Variables:

Complete the table below.

Variable types	Descriptions	
Dependent variable	What are you measuring?	
Independend variable	What are changing?	
Controlled variable	What are you keeping the same?	

Step 2: Data Collection

Use the En-ROADS simulator to test the impact of each policy.

Record data for metrics such as global temperature, CO_2 emissions, and sea level rise.

Policy	Global temperature change (oC)	CO_2 emmissions (Gt)	Sea level rise (mm)
1.			
2.			
3.			

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Step 3: Data Analysis

Which policy had the greatest impact on reducing global temperature and sea level rise? Why?

Were there any unexpected trade-offers or co-benefits?

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Step 4: STEM Solution Proposal

Based on the data and observations gathered across all teams, develop a comprehensive STEM-based solution for for mitigating the effects of climate change.

- Follow the steps below to organize your proposal:

Provide a detailed explanation of the climate problem you observed:

What is the primary issue identified based on your analysis? Which sectors or regions contribute most to this issue? What consequences may arise if this problem is not addressed?

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Develop an innovative stem-based solution for the identified problem: Describe your proposed solution (e.g., technology, policy, or behavioral change). How does your solution address the root causes of the identified problem? What tools or technologies are required to implement this solution effectively?

Explain the sustainability of your solution: How will your solution ensure long-term positive impacts on the environment and society? Does it utilize renewable or eco-friendly resources? How does it align with global sustainability goals?

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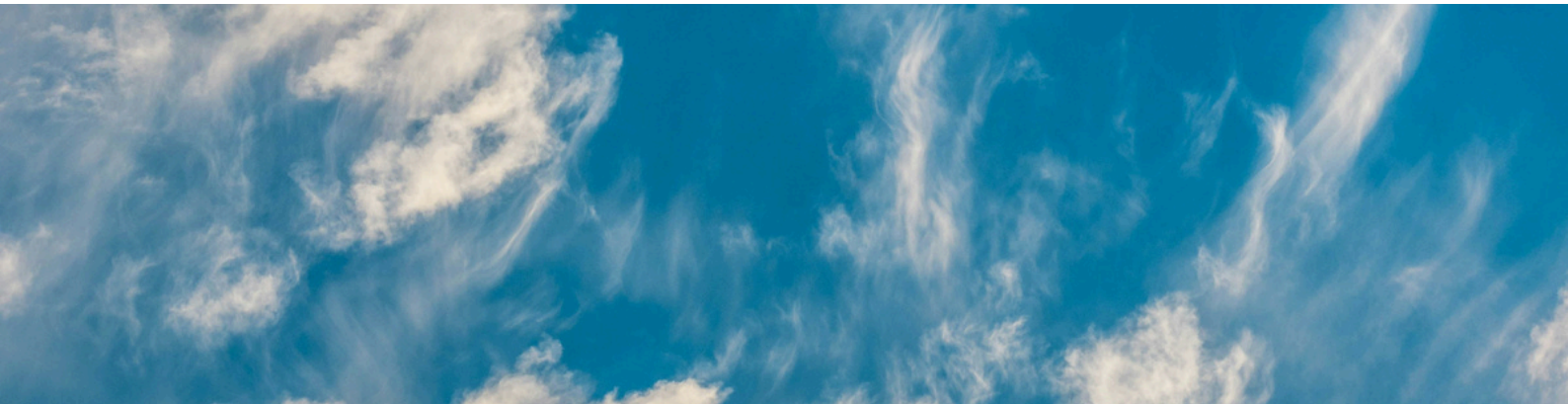
Outline an implementation plan:
Detail the key steps and timelines to roll out your solution. Identify potential barriers and strategies to overcome them. What metrics or indicators will you monitor to evaluate progress?

Evaulate te impact of your solution:
Predict short-term and long-term outcomes. How will your solution help reduce emissions and limit temperature rise? What benefits will it bring to local communities and ecosystems?

Prepare a 5-minute presentation and a short report to share your proposed solution.
The report should include the following sections:

- Summary of the problem and key findings
- Your STEM-based solution and how it works
- Expected outcomes and its contribution to a healthier environment



LET'S MEASURE OUR AIR QUALITY!

Ages 8-15

Environment and Air

120 minutes

Key Concepts

- Air Quality
- Air Quality Index (AQI)
- Particulate Matter
- Air Pollution
- Environmental Health

Purpose: In this activity, it is aimed for students to raise awareness of indoor air pollution, to investigate air quality in different environments, and to enhance their skills in applying STEM based approaches for analyzing data and developing solutions.

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Learning Outcomes

By the end of this activity, students will be able to:

- Define air quality and describe its effects on human health and the environment.
- Explain the concepts of PM2.5 and PM10, including their sources and safety thresholds.
- Design and conduct a comparative air quality experiment in different indoor environments.
- Collect, analyze, and interpret air quality data using scientific methods.
- Develop and propose STEM-based solutions to improve air quality.
- Enhance collaborative problem-solving and critical thinking skills.

Materials

Portable particulate matter mesaurement device, calculator, stopwatch or timer, measuring tape, worksheets, markers and pencils.
Optional Materials for Solution Development: Basic supplies: cardboard, ruler; DIY tools: small fans, filters (e.g., HEPA), sensors, or other low-cost air purification components for hands-on models; tablet, indoor plants, or soil samples (e.g., for teams proposing phytoremediation)

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EDUCATOR GUIDELINES

1- Introduction (15 minutes)

- Begin by discussing the importance of air quality using real-world examples.
- Ask the following questions to engage students:

o What is the atmosphere's role in supporting life?

o What are the main components of the air we breathe?

o What is air pollution, and what causes it?

- Introduce the concepts of PM2.5 and PM10 and explain how these pollutants impact human health.

2- Device Demonstration (5 minutes)

- Show students how to use the particulate matter measurement device.
- Explain the importance of consistency in data collection (e.g., keeping doors and windows closed during measurements).

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3- Experiment Design and Data Collection (45 minutes)

- Divide students into teams of three to five members and assign them specific indoor environments (e.g., laboratory, entrance, corridor).
- Each team will use the provided worksheet to:

o Identify the environments to compare.

o Determine their dependent, independent, and controlled variables.

- Teams will conduct measurements in their assigned environments for at least 3 minutes per location and record the data.

4- Analysis and Discussion (20 minutes)

- Students will calculate averages and compare their data to AQI threshold values (PM2.5: 25 $\mu g/m^3$, PM10: 50 $\mu g/m^3$).
- Facilitate a discussion using questions such as:

o Which environment had the highest particulate matter levels?

o What could be the sources of these pollutants?

o How can air quality in this environment be improved?

5- Developing a Solution Proposal (30 minutes)

- Ask teams to present their findings and propose a STEM-based solution for improving air quality in one of the environments they analyzed.
- Encourage students to refine their solutions by considering the following questions:

o Which environment is your solution most suitable for? (e.g., Would it be more effective in a school corridor or a laboratory?)
o What challenges might prevent its real-world implementation?
o What is the cost of this solution, and how can its sustainability be ensured?
o If you were to conduct a pilot implementation, what steps would you take?

- Encourage students to experience the engineering design process by creating prototypes or model designs. (e.g.,they can design their own air filtration system using small fans and HEPA filters, then compare filtered and unfiltered air quality, they can test the efficiency of different materials (cotton, activated carbon, fabric, etc.) in filtering particulate matter, they can explore how phytoremediation works by using indoor plants and soil samples).

The allocated time can be adjusted based on the number of teams. Ensure each team has enough time to present their findings and discuss their solutions.

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BACKGROUND

What is Particulate Matter (PM)?

Particulate matter (PM) consists of tiny solid particles and liquid droplets suspended in the air. These particles can vary in size and origin, and their impact on air quality and health depends on their size. In this activity, we will focus on:

- **PM2.5:** Fine particles (≤ 2.5 microns) that can penetrate deep into the lungs and bloodstream.
- **PM10:** Larger particles (≤ 10 microns) that typically settle in the upper respiratory tract.

Sources of PM2.5 and PM10

- **PM2.5 Sources:** Vehicle emissions, industrial processes, wildfires, fossil fuel combustion.
- **PM10 Sources:** Dust from construction sites, unpaved roads, agricultural activities, pollen, mold spores.

How is PM Measured?

The concentration of particulate matter in the air is measured in micrograms per cubic meter ($\mu g/m^3$). High concentrations of PM can significantly reduce air quality, impacting both human health and the environment.

Health Impacts of PM Exposure

- **PM2.5:** Long-term exposure can lead to severe respiratory and cardiovascular diseases, including asthma, heart attacks, and even premature death.
- **PM10:** Prolonged exposure may cause coughing, throat irritation, and aggravation of existing lung conditions.

What is Air Quality Index (AQI)?

The AQI is a scale used to evaluate air quality and its impact on human health. The table below shows the safe levels for PM2.5 and PM10:

Pollutants	AQI Thresholds (Safe Levels)	Description
PM2.5	0–25 µg/m³	Safe for health. Levels above 25 µg/m³ can affect sensitive groups and cause health issues.
PM10	0–50 µg/m³	Safe for health. Levels above 50 µg/m³ may cause adverse health effects, particularly for vulnerable populations.

Comparing PM Levels to AQI Thresholds

When measuring air quality, compare the PM2.5 and PM10 values in an environment to the AQI thresholds:

- If PM2.5 is above **25 µg/m³,** air quality is considered **unhealthy for sensitive groups.**
- If PM10 is above **50 µg/m³,** air quality may negatively affect the general population, especially those with respiratory conditions

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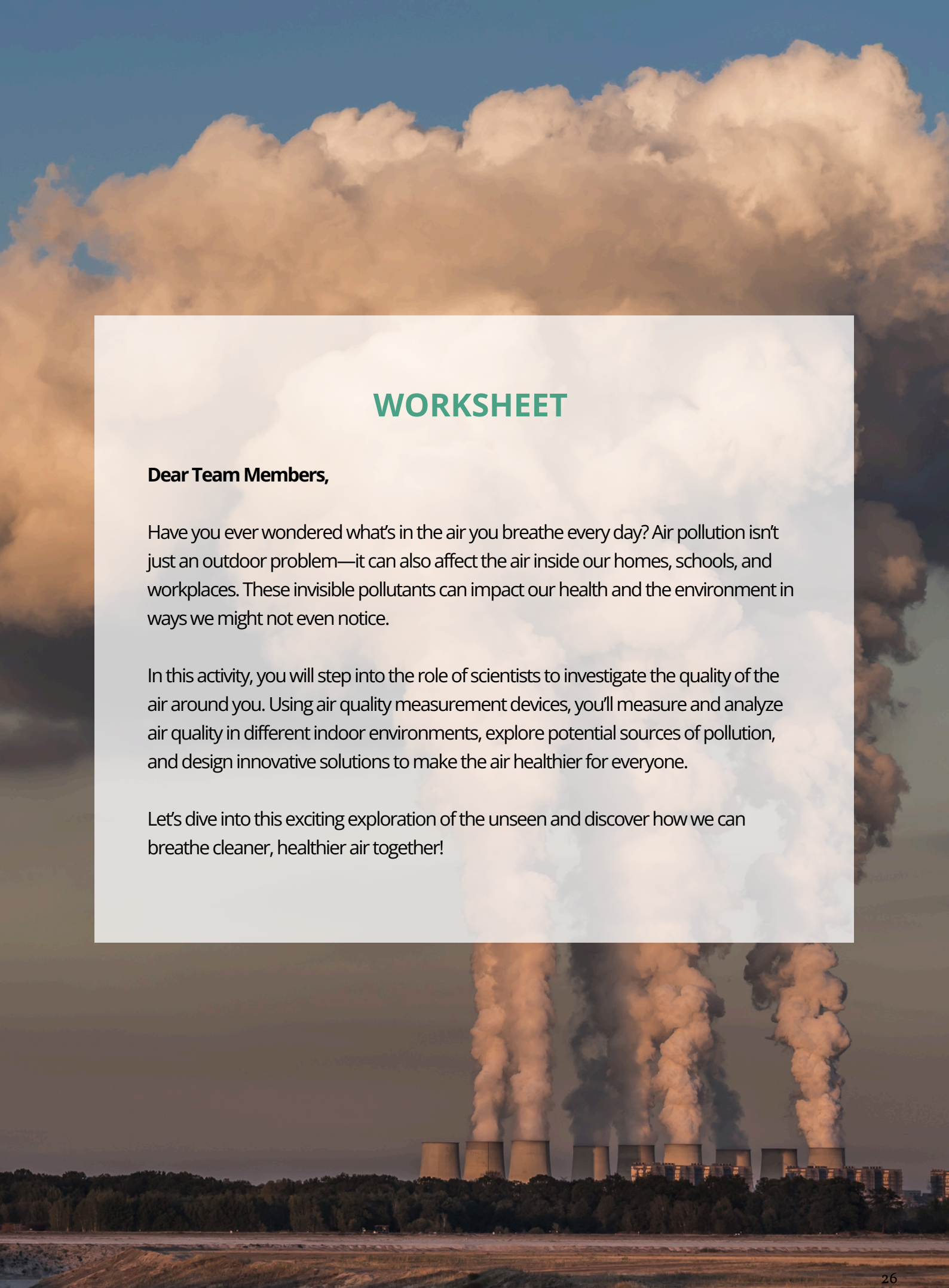

WORKSHEET

Dear Team Members,

Have you ever wondered what's in the air you breathe every day? Air pollution isn't just an outdoor problem—it can also affect the air inside our homes, schools, and workplaces. These invisible pollutants can impact our health and the environment in ways we might not even notice.

In this activity, you will step into the role of scientists to investigate the quality of the air around you. Using air quality measurement devices, you'll measure and analyze air quality in different indoor environments, explore potential sources of pollution, and design innovative solutions to make the air healthier for everyone.

Let's dive into this exciting exploration of the unseen and discover how we can breathe cleaner, healthier air together!

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Step 1: Experimental Design

1- Select Three Indoor Environments to Measure Air Quality:

Write down the environments you have selected to investigate, along with your reasons for choosing them.

Environment 1	
Reason for Selection	

Environment 2	
Reason for Selection	

Environment 3	
Reason for Selection	

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2- Identify the Variables:

Complete the table below.

Variable types	Descriptions	
Dependent variable	What are you measuring?	
Independend variable	What are changing?	
Controlled variable	What are you keeping the same?	

Step 2: Data Collection

Use the particulate matter measurement device to measure air quality in each environment. Ensure all doors and windows are closed during measurements. Record data for at least 3 minutes per environment and note the results below.

Environment	PM2.5(µg/m³)	PM10(µg/m³)	Room dimensions(m²)	Room volume(m³)
1.				
2.				
3.				

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Step 3: Data Analysis

Which environment had the highest PM2.5 and PM10 levels? Why do you think this is the case?

Compare your results with the AQI thresholds. Were any environments above the limits?

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Identify potential pollution sources in the environment with the highest PM (Particulate Matter) levels?

Suggest three ways to improve air quality in the most polluted environment:

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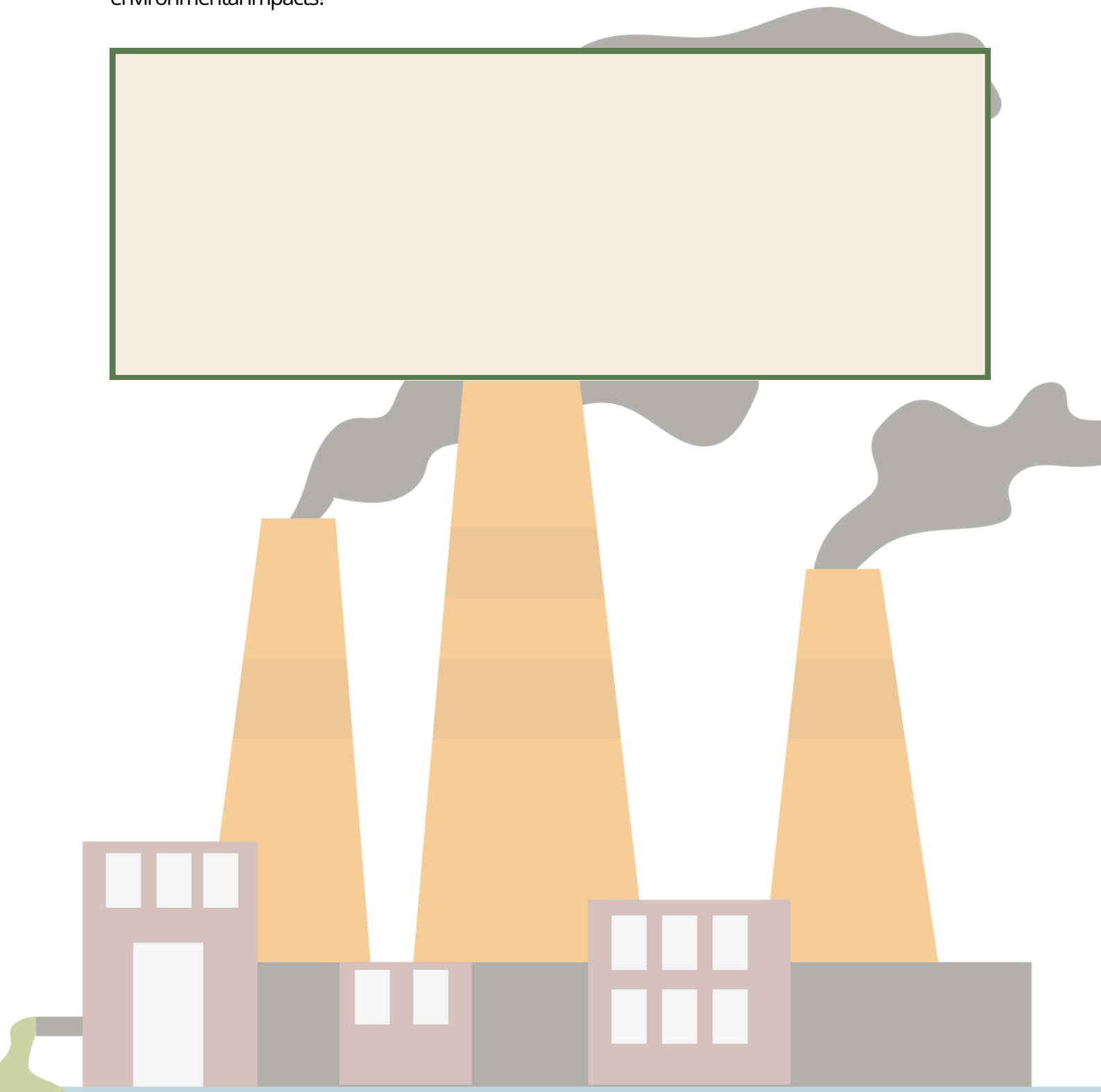
Step 4: STEM Solution Proposal

Based on the data and observations gathered across all teams, develop a comprehensive STEM-based solution to improve air quality in the environment with the highest pollution levels.

- Follow the steps below to organize your proposal:

Which environment had the highest level of air pollution? What are the possible sources of pollution in this environment? If no action is taken, what could be the potential health and environmental impacts?



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What device, system, or approach will you use? (e.g., installing air purifiers, creating a ventilation system to improve natural airflow, phytoremediation, etc.)

How will you design or adapt this solution for a specific environment? (e.g., Where will the air purifier be placed? What energy sources will be used? How will the solution be implemented?)

How will this solution be sustainable and eco-friendly? (e.g., using renewable energy, avoiding unnecessary waste, incorporating nature-based solutions such as indoor plants.)

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Draw a simple diagram or sketch to illustrate how your solution will work.

List the materials or tools required to implement your solution.

Develop a step-by-step implementation plan or a timeline to execute your solution.

Evaluate the impact of your proposed solution on air quality, health, and the environment: How will PM2.5 and PM10 levels improve? What positive effects will this solution have on health and the environment? How will you measure the effectiveness of your solution?

Identify potential challenges or limitations in implementing this solution and propose strategies to overcome these obstacles.

Prepare a 5-minute presentation and a short report to share your proposed solution. The report should include the following sections:

- Summary of the problem and key findings
- Your STEM-based solution and how it works
- Expected outcomes and its contribution to a healthier environmentor limitations in implementing this solution and propose strategies to overcome these obstacles.

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Proje Adı / The Title of The Project
E-STEM ile Çocukların Çevresel Sürdürülebilirlik için Güçlendirilmesi / Empowering Children for Environmental Sustainability through E-STEM

Proje Ortağının Adı / Name of The Project Partner
Uluslararası Kalkınma ve Çevre Derneği – IDEA Universal / International Association for Development and Environment – IDEA Universal

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