MODULE I

Lesson Plan 3

Summary

Lesson title

Carbon footprint - Atmospheric CO_2 data analysis.

Duration	90 min
Proposed student's age range	10 - 14

Lesson summary

Atmospheric CO2 (carbon dioxide) data collected from two observatories are plotted. Their long-term trend and seasonal variations are analysed. The differences between natural cycles and those caused by climate change are highlighted.

Learning outcomes

Purpose/Learning Objective

- Graph CO_2 (carbon dioxide) data to learn about natural cycles and unnatural changes in our atmosphere.
- Analyse the trend by viewing the longest available data series from the Mauna Loa observatory to see the effect of climate change.
- Comparing data from two observatories in different hemispheres

Intersecting objectives

- Understanding and explaining environmental processes and systems.
- Knowledge in representing and analysing data
- Ability to handle specialised data analysis software

Connection to SDGs

This activity is aligned with SDG 13: “Take urgent action to combat climate change and its impacts” Target 13.3: Improve education, awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning.

Implementation

Facilitation

- It is recommended that students be grouped into teams of 2-4 to carry out this activity.
- Download data (from the website or the files provided) and distribute them to the student groups before the lesson to save time.
- Data sets for 2 years can be distributed to each group.

Resources required

- Internet
- Projector
- At least 1 laptop for each group (with Microsoft Excel or Calc)
- Monthly CO_2 data 2010-2021 from:
    - Mauna Loa observatory https://gml.noaa.gov/obop/mlo/
    - South Pole Observatory https://gml.noaa.gov/obop/spo/

Ideas for follow-up

Check the NOAA (National Oceanic and Atmospheric Administration) CO_2 observatories in Europe from the website of any previous observatories and analyse the data from any of them.

Understanding Ocean & Coastal Acidification: Explore relationships between carbon dioxide and ocean pH with this educational module designed by NOAA.

Source / Materials & class preparation

- This activity is based on: https://www.exploratorium.edu/snacks/our-changing-atmosphere created by Exploratorium Teacher Institute, licensed under Creative Commons Attribution-Noncommercial-ShareAlike 4.0. (https://creativecommons.org/licenses/by-nc-sa/4.0/)

- Full explanations about data CO_2 series cycles: https://climate.nasa.gov/vital-signs/carbon-dioxide/?intent=121

- The e-book "Understanding CO_2" describes what CO2 is, its applications in different fields, the meaning of its units of measurement (ppm), and why it is important to measure it.

Tutorials for creating charts in Excel:

- Create a chart from start to finish
- Create pie, bar, and line chart
- Present your data in a scatter chart or a line chart

Instructions for downloading observatory data:

- Click “Data Viewer”, select: “Carbon Cycle Gases” and then “Time Series”
- Parameter: CO2, Data Type: In-Situ Data, Data Frequency: Monthly Average, and finally, choose the range of years between 2010 and 2021.
- A Txt file is downloaded and must be opened from Excel, separate the data into columns and delete all the columns that are not of interest.

Lesson Outline

Timing	Instructions step-by-step
10 min	**Introduction to Excel or Calc** Explain the different types of charts available in Excel or Calc.
35 min	**Practising with charts** Practice with students using some example data to create a line chart and scatter plot in Excel or Calc.
5 min	**Introduction to CO_2** Explanations of what CO_2 is. Its natural cycles and human activities cause its level to rise in the atmosphere.
10 min	**CO_2 Data Series** Explanation of data series of CO_2. Where are data being collected, frequency and units of the data… Visit this website and ask students if Mauna Loa is in the Northern or the Southern Hemisphere. Use the Data Viewer to graph all available Mauna Loa observatory data. Ask students to describe and explain the reasons for the long-term trend in the data.
15 min	**Plotting the data** Each group of students must graph the data from two years in scatter charts: one chart for each observatory and one more graph with the data from both observatories.
15 min	**Analysing the data** Ask the students: What do you notice in the Mauna Loa data? When are the values the highest? The lowest? Ask students to describe and explain the short-term variability in the data. Discuss this seasonal variation. Ask the students: What do you notice about the seasonal fluctuation pattern in the Northern and Southern Hemisphere? Why do you think these different patterns occur in the data?

Formative assessment

Methodologies: Classroom observations, oral questions, group discussion
Instruments: Quizzizz or Kahoot

Feedback

Net Promoter Score (NPS) is a widely used metric to gauge the loyalty and satisfaction of customers or, in an educational context, students. It measures the likelihood of the students recommending the lesson or course to others. Here is how you can describe and implement NPS:
Develop the NPS Question:

- Primary Question: "On a scale of 0 to 10, how likely are you to recommend this lesson to other students?"
- Follow-up Questions: "Why did you choose that score?" and "How can we improve this lesson?"

Collecting Responses:
A template for collecting feedback using paper surveys is shown in the Annexes.

- Digital Surveys: To distribute the NPS questions to students, use online tools like Google Forms, SurveyMonkey, or Typeform.
- Paper Surveys: Hand out paper questionnaires at the end of the lesson for students to fill out.
- Interactive Applications: Utilize interactive apps like Quizziz, Mentimeter, or Kahoot! to gather real-time responses.

Classifying Responses:

- Promoters (Score 9-10): Students who are highly satisfied and likely to recommend the lesson.
- Passives (Score 7-8): Students who are satisfied but not enthusiastic and could easily change their opinions.
- Detractors (Score 0-6): Students who are dissatisfied and unlikely to recommend the lesson; may provide constructive criticism.

Calculating the NPS:

- Formula: NPS = % of Promoters - % of Detractors.
- Interpreting the Score: NPS ranges from -100 to +100. A positive score (above 0) is generally good, and a score above 50 is excellent.

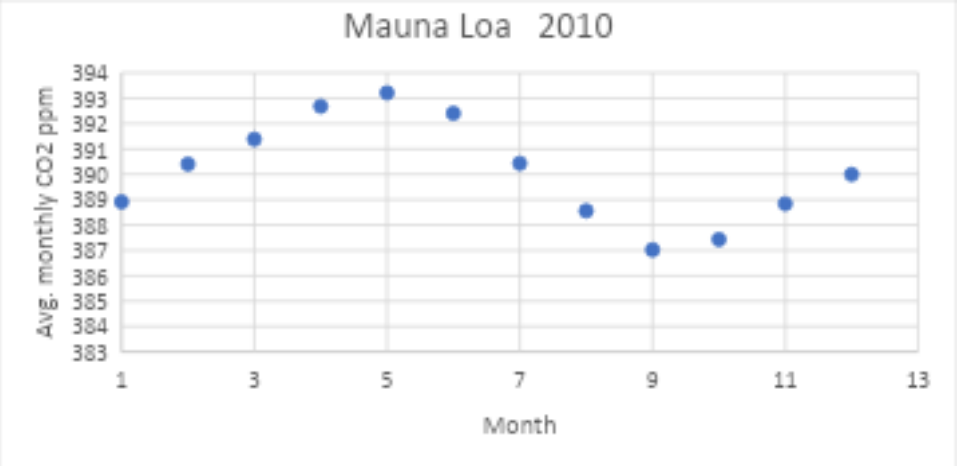
Analysing and Using Feedback:

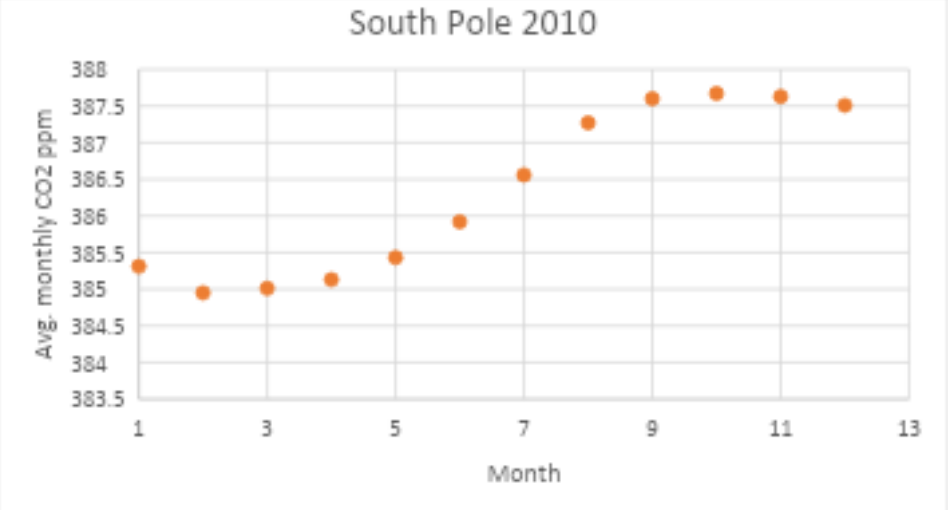
- Review additional comments to understand the reasons behind the scores.

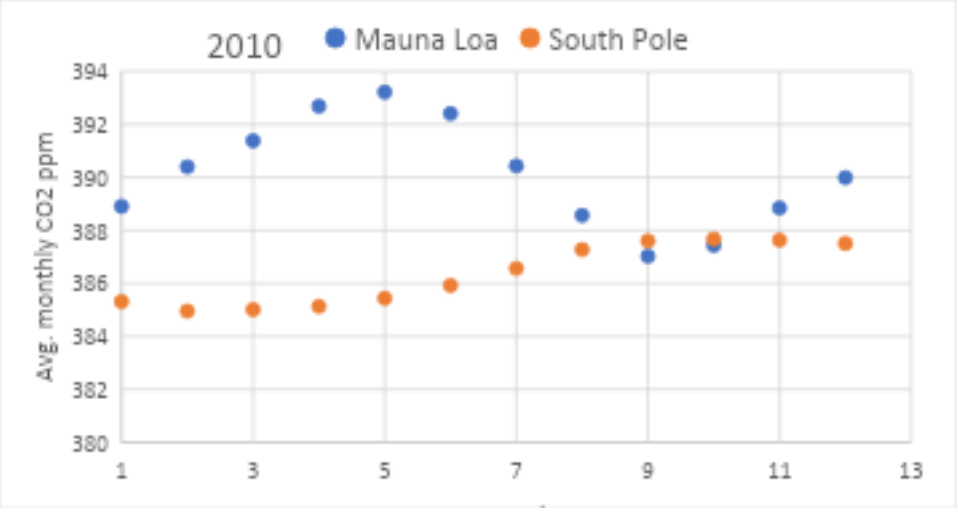
- Identify patterns and specific areas for improvement from detractors and passives.
- Use positive feedback from promoters to reinforce successful aspects of the lesson.

Annexes

Examples of the plots that the students should obtain







QUESTIONNAIRE TO COLLECT FEEDBACK ON THE LESSON

On a scale of 0 to 10, how likely are you to recommend this lesson to other students?

0	1	2	3	4	5	6	7	8	9	10

Not likely at all Extremely likely

Why did you choose that score?

How can we improve this lesson?