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Promoting STEAM through participatory urban regeneration

2024-1-IT02-KA220-SCH-000251173

Laboratory

Atmospheric CO_2

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FREELAND laboratories follow the structure of Inquiry Based Learning, in 5 steps (orientation, conceptualisation, investigation, conclusion and discussion), and for each step we suggest activities and methodological approaches that are engaging for the students, such as brainstorming, hands-on, creative works. The activities described in the laboratory are suggestions that teachers can adapt or replace with similar activities suitable for students' age and school type.

Laboratory	**Atmospheric CO2**
Duration:	1 hour outdoor & 1 hour indoor
Tools:	Worksheet CO_2 Gas Analyzer Excel for calculations (or calculators)
Technologies:	CO_2 Gas Analyzer
Subjects:	Science (Biology), Maths, Physics
Students' age	Any
School type	Any
Disciplinary contents:	CO_2 is the most known and abundant greenhouse gas in the atmosphere. Despite its concentration is little (0.04%), its presence is very important to keep the planet warm enough for life - thanks to its presence, Earth's average temperature is about 15 °C, without extremes between day and night (typical of planets without atmosphere) - although rising concentrations are the main cause of global warming. Indeed, CO_2 is a greenhouse gas which means that the molecules trap solar energy (infrared radiation), warming up the atmosphere, and preventing radiation from dissipating in the airspace. The concentration of CO_2 in the atmosphere has risen a lot since the industrial revolution, with a peak since the 60ies of the past century due to anthropogenic activities. In 2024, the average world concentration was 422 ppm. This laboratory is about the measurement of CO_2 in the atmosphere in different urban spaces (street vs parks, etc.) to understand how CO_2 varies depending on the characteristics of the environment and the distance from the sources and to reflect on solutions to lower its concentration.

Learning objectives:	Students will be able to: • Make measurements of CO_2 in urban environments • Organize data and make graphs • Discuss the results and make relationships with the characteristics of the environment

For each phase of the IBL we describe the suggested activities.

Orientation

Duration:	15 minutes indoors
Tools:	No specific tools
Technologies:	No
Subjects:	Science/Physics/Chemistry
Method:	Brainstorming

The teacher introduces the students to the topic.

"Life developed on Earth mainly for two reasons: the presence of water and not extreme temperatures. What is the connection between the air temperature and atmosphere?

Students should recall their prior knowledge to answer the questions. The composition of the atmosphere is important as the greenhouse gases such as water vapor and carbon dioxide, trap part of the sun's heat and emitted by Earth, generating the greenhouse effect as a natural phenomenon. This makes the Earth habitable, maintaining the average temperature at about 15 °C.

Note: CO_2 is produced by any living organism through respiration. The presence of CO_2 in the atmosphere has allowed the development of life on the planet due to the fact that it traps solar energy, warming up the atmosphere. Then, plants use CO_2 for photosynthesis. Since the industrial revolution, and especially from the 60ies of the past century, the concentration has risen more than normal, causing global warming and altering climate.

Conceptualization

This phase concerns the creation of the question to be answered by an investigation.

Duration:	5 minutes outdoors
Tools:	No specific tools

Technologies:	No
Subjects:	Science/Physics/Chemistry
Method:	Brainstorming

Following orientation, the teachers invite the students to hypothesize whether the CO_2 changes according to the characteristics of the environment (presence of vegetation, characteristics of the street, and the sources of CO_2, such as the presence of traffic or heating systems).

"How does CO_2 change? What are the factors that affect its concentration?"

Investigation

The investigation includes an activity that will answer the question posed.

Duration:	1 hour outdoors
Tools:	Pen and notes
Technologies:	CO_2 gas analyser
Subjects:	Science, Maths, Physics
Method:	Hands-on.

In order to assess CO_2, students need to collect data in different spots (e.g. from the street to the inner part of a park or inside the selected area. The tool measures continuously, so students should write the numbers (e.g.: each minute for 5 times).

Tools:	CO_2 gas analyzer such as: https://alexnld.com/product/ht-2000-portable-9999ppm-co2-meter-monitor-detector-gas-analyzer-temperature-relative-humidity-test/?gad_source=1&gad_campaignid=17338203267&gclid=CjwKCAjwxfjGBhAUEiwAKWPwDo4ZptrbcLA4xNkUN7O80ZR-21aCOU8RxaSU-umNdx2yNYpcvjI-QBoCiaoQAvD_BwE	

Planning and performing sampling

Students decide where they want to take the measurements, for example:

Sites	CO_2 concentration (ppm)
Street	5 measurements
Car park	5 measurements
Park	5 measurements
…	…

Data acquisition and elaboration

The students fill in a table with the values of CO_2 (see worksheet)

Conclusion

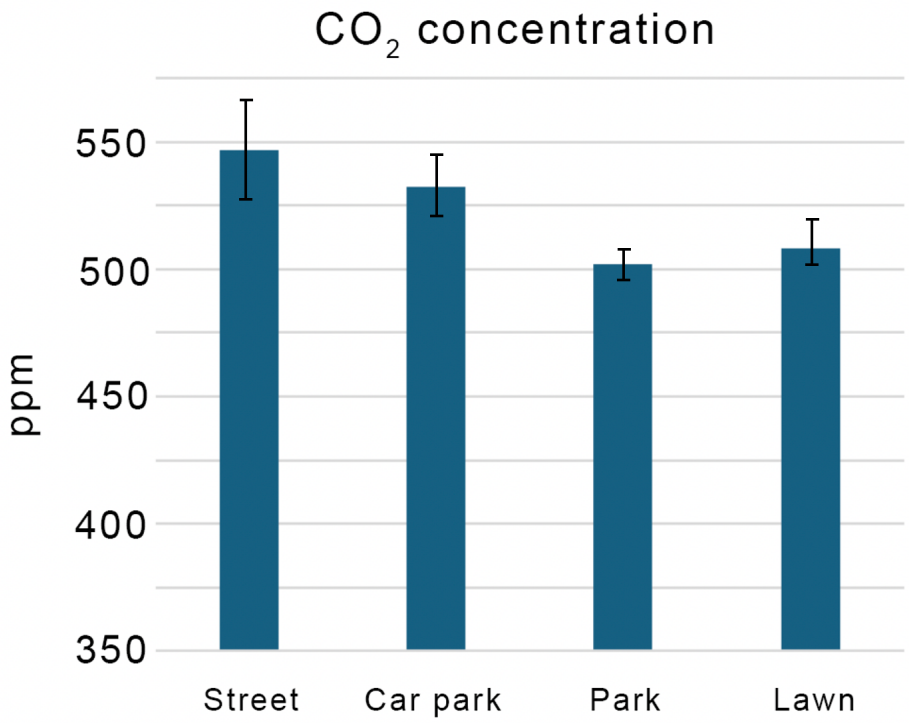
This phase concerns the analysis of the data to obtain the results that will be discussed in the next phase.

Duration:	15 minutes indoors
Tools:	Pencils and notes/Excel
Technologies:	PC or notebook
Subjects:	Math
Method:	Simple data analysis (average)

The 5 values of CO_2 in each site can be expressed as average and standard deviation.

Students can use an open web-app to create graphs or insert the final data in the Platform to visualise the results.

Sites	CO_2 concentration (ppm)	Standard deviation
Street	Average of 5 measurements	
Car park	Average of 5 measurements	
Park	Average of 5 measurements	
...	...	...



Discussion

In this phase, students reflect on the findings.

Duration:	30 minutes indoors
Tools:	Pen/notes/PowerPoint
Technologies:	PC
Subjects:	Science (Biology), Math
Method:	Brainstorming

Students, in groups, reflect on the average values of CO_2 and the characteristics of the places where the data were taken.

Students are invited to think about solutions for lowering the values of CO_2 (searching for species of trees that are effective in absorbing CO_2, closing the traffic to vehicles, etc.)

The elements will be listed to be included in the 3D model.

Outcomes:

- 3D visualisation of the project (one student group will recreate the place virtually with the support of the **Platform**).
- Labels (optional) of species that can be placed in the area, with the description of the species.
- Reports, presentations, or videos that can be evaluated by teachers following the school's evaluation grid.

Appendix:

Worksheet for the students

Date of survey: _____

Time: _____

Town: _____

Names of surveyors: _____

Take at least 5 measurements on each location

Location name	Description	CO_2 (ppm)	CO_2 (ppm)	CO_2 (ppm)	CO_2 (ppm)	CO_2 (ppm)	Average CO2 (ppm)	Standard deviation (ppm)
	Park with trees							
	Lawn							
	Street with many cars							
…	…	…	…	…	…	…	…	…

Co-funded by the European Union