ERASMUS+ KA220-SCH - Cooperation partnerships in school education

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Promoting STEAM through participatory urban regeneration

2024-1-IT02-KA220-SCH-000251173

Laboratory

What is in the air?

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FREELAND laboratories follow the structure of Inquiry Based Learning, in 5 steps (orientation, conceptualization, 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 to students' age and school type.

The a	**What is in the air?**
Duration:	4 -5 hours: 2 hours outdoors & 2 - 3 hours indoors
Tools:	Worksheet to print, Pen and notes, pieces of white thick paper, vaseline,
Technologies:	Mobile phones for photos, audios and videos, microscope, laptop and software for creating presentations and videos
Subjects:	Science (Chemistry), Mathematics, Civic education, Art; ICT
Students' age	Any
School type	Any
Disciplinary contents:	This laboratory focuses on air pollution in urban areas There are several pollutants in the air, mainly produced by anthropic activities (e.g. gas such as CO, l'ozone (O3), nitrogen dioxide (NO2) and sulphur dioxide (SO2) hydrocarbons, particle matters (PM) produced by fossil fuel combustion). Other substances, naturally produced such as volatile organic compounds (VOC) and pollen emitted by plants can be also harmful due to allergens. The pollutants can have harmful consequences. For instance, PM10 concentration in the air over a certain threshold can be harmful for our respiratory apparatus. This laboratory includes a series of educational and practical activities aimed at raising students' awareness about the air pollution around us and its causes, measuring the effective level of some pollutants in the

	selected area and reflecting and proposing actions to reduce them.
By Learning objectives:	Students will be able to • Estimate the level of PM in the air by doing a simple experiment in the selected area • analyze and compare collected data • present the results of their activities through video and/or presentation • reflect on the impact of our daily activities and habits on the quality of a living space in relation to air pollution • discuss scientific results and make relationships between diverse disciplines, in connection to air pollution

For each phase of the IBL we provide a description of the suggested activities.

Orientation

Duration:	15 minutes outdoors or indoors
Tools:	No specific tools
Technologies:	No
Subjects:	Science (Physics), Civic education
Method:	Brainstorming

The teacher discusses in the classroom and asks each student, which are the types of air pollutants they know or they experience in their daily life. The teacher can use a video of a busy road or other situation of daily life and ask students to reflect on what type of air pollution they expect

Conceptualization

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

Duration:	15 minutes outdoors or indoors
Tools:	No specific tools
Technologies:	No
Subjects:	Science (Physics), Civic education
Method:	Brainstorming

Invite the students to feel the sensations they perceive in the place they area and to raise questions regarding or guide them by posing questions such as,

Do you perceive any strange feeling or smell in the air?

"Which type of pollutants can be present in this place and which are their sources?"

Do you think that air pollution is uniformly distributed?

Do you think it can be harmful?

Reflecting on this question the students make a plan of the places or spots within the selected area they want to monitor and the protocol to follow to do the data collection.

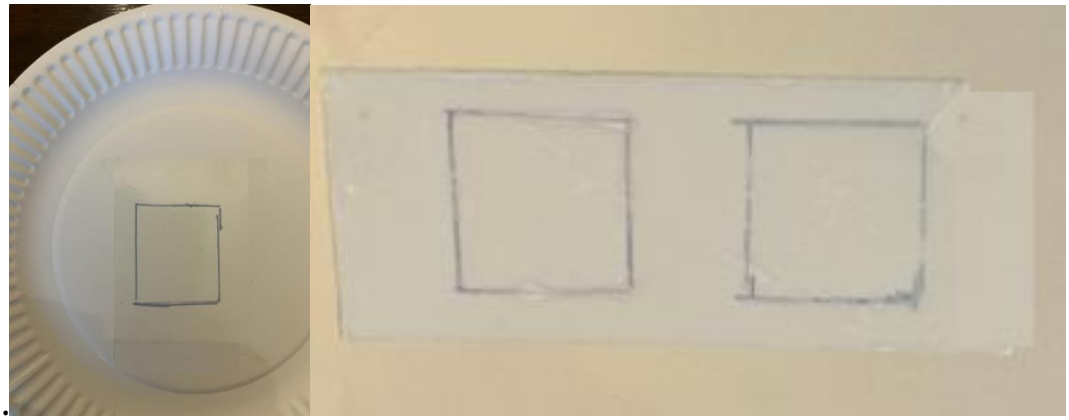
Investigation

The investigation will answer the posed questions. This means investigating the types, the sources and levels of air pollution of the chosen place, focusing on particulate matters because it can be estimated by using low cost tools and can be harmful for our health due to high concentration and long exposure to them.

Duration:	30 minutes indoors, 1:30: hours outdoors
Tools:	For each group • pens • worksheet “Noise detection” (see appendix)
Technologies:	Mobile phone to take pictures, videos and record sounds, app for measuring sound/noise intensity (e.g soundmeter)
Subjects:	Chemistry, Civic education, ICT
Method:	Hands-on laboratories

Planning and performing the activity

Select one or more areas (e.g. indoor the school, outdoor in a neglected space) and identify spots to be investigated (e.g. outdoor, select spots at different distances from a source of air pollution such as a nearby street, a garage, etc.). Identify each spot with a code that you will use to identify the place during data collection. Then you can create air pollution catchers. For instance, you can cover a paper plate (https://youtu.be/9uVdi-3AqRE) or a transparent sheet (https://www.youtube.com/watch?v=ey3TpTmLzWg) with a layer of vaseline on top or put a double-sided adhesive tape on the sheet to build your own air pollution catchers. Students draw a square box in the air pollution catcher to mark the section that will be sampled for the presence of PM_{10}. If you want to be more precise, you can draw multiple sampling boxes and calculate the PM_{10} concentration in each one. This allows you to perform statistical analysis on the data collected from different areas of the catcher.



An air pollution catcher is composed of a piece of double-sided adhesive tape attached to a paper plate. The marked area indicates the section sampled for the presence of PM_{10} pollutants

Then, place the air-pollution catchers outdoors at locations situated at different distances from the main pollution source (e.g., a busy road). Remember to record the distance on each catcher so you know where it was collected. Leave the catchers in place for a long period of time (e.g., one month) or for a shorter period (from one day to one week). Be careful not to contaminate the samples during this process.

Choose the dates and the periods looking at the weather forecast and if possible, choose a period with low rain probability. At the end of the sampling period, remove the samples and carry them to the lab without contaminating them.

Print the worksheet (Appendix) (one per group) to carry out the different laboratories and activities

“Use a microscope to count the number of particulate matter particles present in each box of the catcher and record the data in the ‘Pollutants’ worksheet (see appendix). Enter the following information: the date the sample was set out, the distance in meter from the pollutant source, the number of day, the total number of particles counted in the selected boxes, the total area of tshe boxes, and the number of effective exposure days (from the time the paper was set out to when it was collected).

Add weather data from a nearby station during the 24 hours: mean temperature, presence of rain and mean wind speed.

Conclusion

This phase concerns the analysis of the data gathered in the investigation.

Duration:	1-2 hour indoor
Tools:	Pencils and notes
Technologies:	PC or notebook
Subjects:	Chemistry, Civic education, Art, Mathematics, ICT
Method:	Report and analysis of the observations Mapping noise Draws of student's ideas of improvements/design projects

In this phase the students analyze data and present results with a linear plot showing the concentration of particle matters vs the distance from a source in meters.

Distance from the main source of pollution (m)	Number of particles	Sampled area (m2)	Day of exposure.	Rainy days
1	*108*	*0.05*	*30*	*2*
3	96	*0.05*	30	2
5	69	*0.05*	30	2
10	42	*0.05*	30	2

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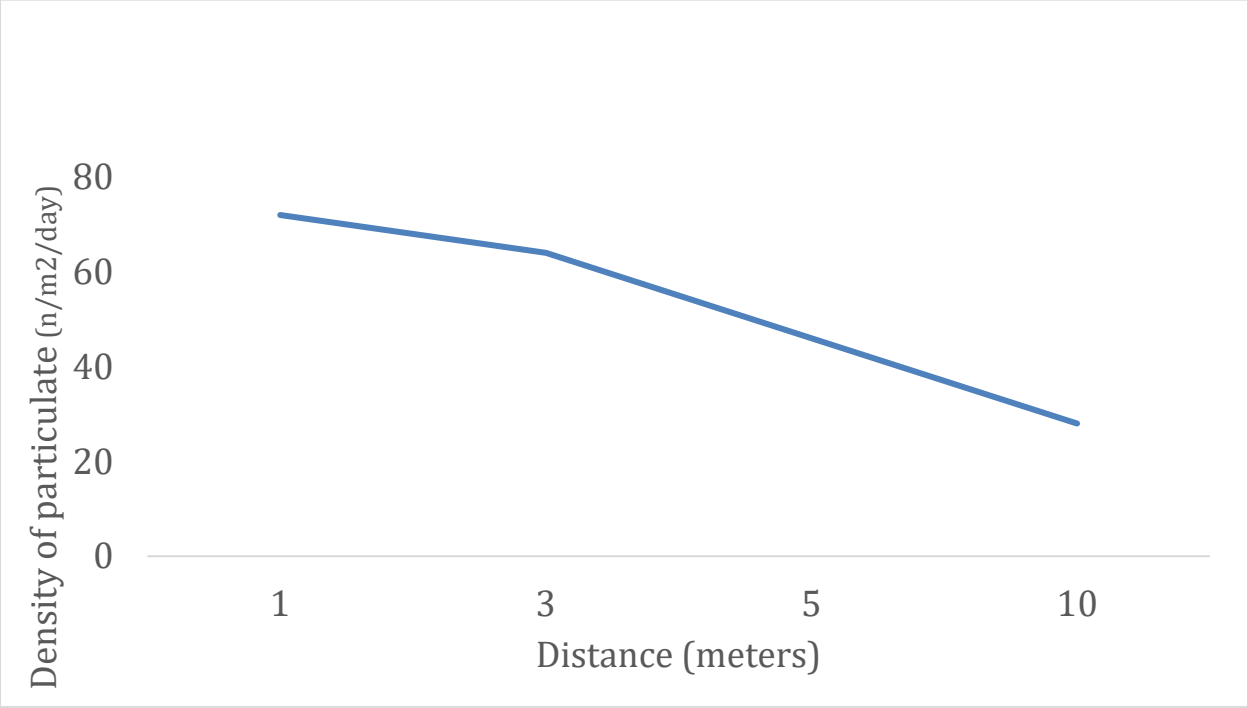
To prepare data for the plot, they can calculate the density of particulate matter per square meter per day for the given time period by dividing the total number of particles by the total surface area of the sample boxes and by the number of exposure days. They can then create this table in a spreadsheet or CSV format to upload to the platform in order to generate the linear plot, as shown in the example..

Distance from the main source of pollution (m)	Density formula	Density of particle matters per square meter and per day ($n/m^2/day$)
1	*108/0.05/30*	*72*
3	*96/0.05/30*	64
5	*69/0.05/30*	46
10	*42/0.05/30*	28



Plot of the density of particulate vs distance from the main source of air pollution

They can compare and discuss the results, the role of distance from the source and consider if the number of rainy days in the study period may have influenced particulate presence on the detector.

Discussion

In this phase students reflect on the findings. They are able to answer the original question and reflect on it.

Duration:	0.30 hour indoors
Tools:	Pen/notes/Powerpoint
Technologies:	PC
Subjects:	Chemistry, Civic Education, Art, ICT
Method:	Brainstorming, group work

Circle time or brainstorming can be useful to involve the students in the discussion phase which will finally answer the initial question. They can indicate what kinds of illness are originated by air pollution.

Based on the results obtained by the analysis of the data, each student will be able to tell which are the spots that are more affected by pollutants and can think or propose ways to reduce their concentration to be implemented in the 3D modeling platform.

Students should be able to exactly indicate what they would like to add or change in the area and present their design projects or sketches of ideas, or verbal description for the 3D modeling platform. With the involvement of the Art teacher, students can create an installation of artistic objects representing air pollution catchers and place them in the most significant locations within the selected area, from the point of view of air pollution.

Outcomes:

- 3D visualization of the project (one student group will recreate the place virtually with the support of the **Platform**).
- Report or presentation or video, that can be evaluated by teachers following the school's evaluation grid.

Additional reading materials:

1. Youtube video “How to Make a Pollution Catcher” https://youtu.be/9uVdi-3AqRE
2. Youtube video “How to Make a Pollution Catcher” https://www.youtube.com/watch?v=ey3TpTmLzWg
3. European Environmental Agency - Air pollution home page https://www.eea.europa.eu/en/topics/in-depth/air-pollution

Appendix:

1. Worksheet: Pollutants

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1. Worksheet: Pollutants

Date start: 1/1/2025 **Date end**: 1/31/2025

Group name: *Urban explorers*
School name. *Lyceum Copernico* **Country:** *Italy*
Date: *20/11/2025* **Location**: *Prato*
Description of the place: *small green area with concrete and grass surfaces, some trees and benches near a busy road*

Distance from the main source of pollution (m)	Number of particles	Sampled area (m2)	Day of exposure.	Rainy days
1	*108*	*0.05*	*30*	*2*
3	96	*0.05*	30	2
5	69	*0.05*	30	2
10	42	*0.05*	30	2

Fill in the table following this procedure:

- **Date start**: date of setting of the papers
- **Date end** date of removal of the papers
- **Group student name**: indicate the name of the group that makes the measurements
- **School name**: name of the school
- **Country**: country of the school
- **Date**: of the observation
- **Location**: name of the place
- **Description**: provide a brief description of the area:

For each paper fill a row with:

- **Distance from the main source of pollution (m):** distance in meters from the main source of air pollution (e.g a busy road)
- **Number of particles**: total number of particle matters present in the boxes of each piece of paper (see Investigation)
- **Sampled area (m2)**: total area of the boxes drawn on each piece of paper (see Investigation)
- **Days of exposure**: days of exposure outdoor
- **Rainy days** fnumber of rainy days during the period of exposure from nearest available weather station