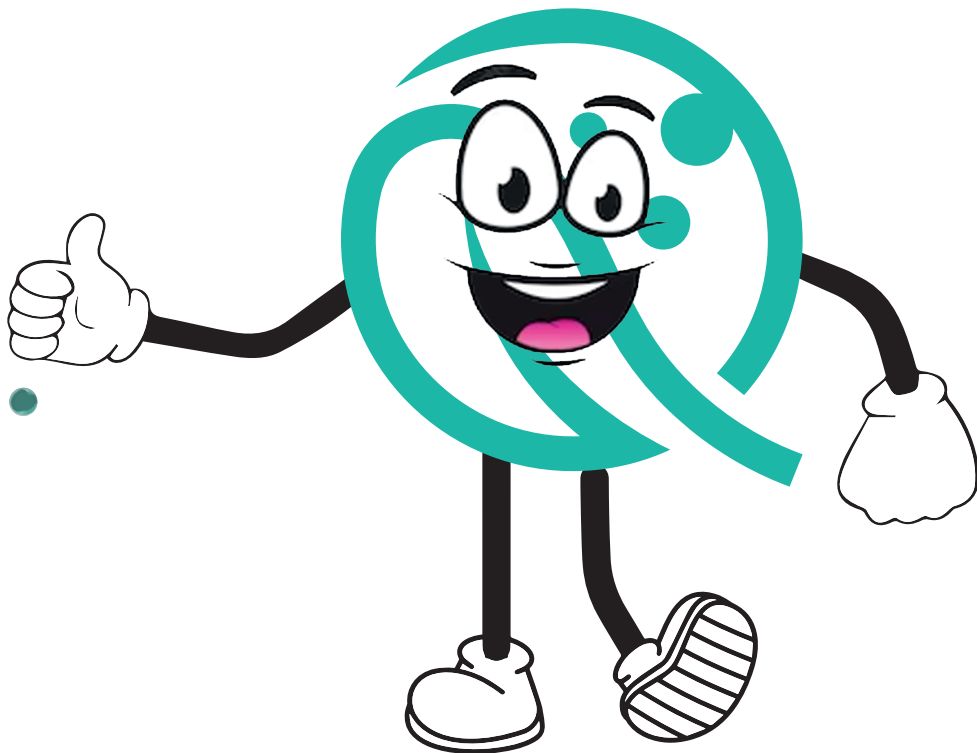


TEACHER'S guide

ABOUT INDOOR AIR QUALITY



EVIDENCE DRIVEN INDOOR AIR QUALITY IMPROVEMENT

Work Material for Developing the EDIAQI Project
I+D+i EDIAQI Project: Evidence Driven Indoor Air Quality Improvement.

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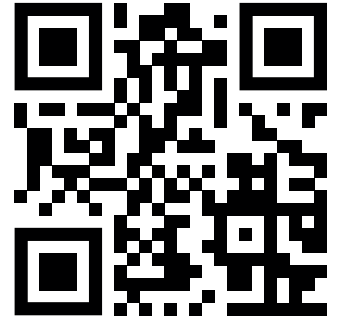
DEAR TEACHER...

Before we begin, it's important for you to know a bit more about EDIAQI;

What is EDIAQI??

EDIAQI (Evidence Driven Indoor Air Quality Improvement) is a research and innovation project funded by Europe under the Horizon Europe framework program, where indoor air pollution in European cities is studied. Its main objective is to understand the sources, exposure pathways, and health effects of indoor air pollution. The project brings together 18 organizations from 11 different European countries, providing a combination of interdisciplinary skills and expertise in various fields.

Learn more 



EDIAQI Website

Why study indoor air quality?

Indoor air pollution is a recognized emerging threat to European society and claims millions of lives each year. People are constantly exposed to both indoor and outdoor air pollution; in fact, recent research shows that individuals in developed countries spend up to 90% of their time indoors.

Poor indoor air quality, along with pollution from biological agents related to moisture and mold, increases the risk of respiratory illnesses by 50%. Although poor indoor air quality poses a significant health risk, it affects people in different ways, and certain populations are more vulnerable: children, the elderly, and people with respiratory illnesses are more sensitive to these environmental risks than the general public.

Why raise awareness among the youngest?

Providing information and education through environmental experiences is crucial at an early age to reinforce students' education, as several studies highlight the importance of childhood environmental education in influencing environmental attitudes and lifestyles in adulthood. Engaging in environmental awareness activities at an early stage, along with the example set by the interest in environmental care from the students' surroundings, are key positive input variables for future student behavior.

AIR QUALITY



What is air?

Air is a mixture of invisible gases that surrounds the planet Earth. It is vital for all living organisms as it contains the oxygen we breathe. Therefore, it is essential that the air we breathe is not contaminated.

How is outdoor air polluted?

Air can be polluted in various ways due to sources of natural origin (from the environment) and sources of artificial origin (produced by humans).

A small portion of pollution comes from sources of natural origin, such as gases produced by volcanic eruptions or forest fires. These events are beyond our control.

The pollutants produced by artificial sources are responsible for the majority of pollution. An example of these are the gases produced by factories or emitted by motor vehicle exhaust pipes.

What is air quality?

Air can be contaminated to varying degrees. When the air is less polluted, we say there is good air quality, and when the air is more polluted, we say there is poor air quality. Air quality is measured using the Air Quality Index. Therefore, we talk about air quality when we want to classify how contaminated the air is.

How is indoor air polluted?

Indoor air can become polluted due to various reasons:

- If outdoor air is polluted, when we open doors and windows, the contamination can enter the interior of the rooms.

- Inside the rooms, pollution can be generated due to the use of cleaning products, air fresheners, perfumes, tobacco smoke, or scanners.

Why is it important to care for indoor air quality?

The pollution of outdoor air in cities has increased in recent years. This directly affects the air breathed indoors, especially in densely populated areas such as large cities.

On average, people spend 90% of their time indoors, such as at school, work, or in their homes.

How does poor indoor air quality affect us?

Air pollution affects us all, but it is especially dangerous for children, pregnant women, and the elderly. Additionally, individuals with respiratory or cardiovascular diseases are more vulnerable.



Breathing polluted air has harmful effects on health, causing various types of illnesses.



This guide contains more detailed information about pollutants than the students' activity workbook. In each section, you will find a brief summary of how to conduct each activity associated with each pollutant. These are just small guidelines, which can be modified if you deem it necessary for the students' proper understanding of the content.

You will have access to audiovisual material to serve as explanation and introduction for the students. A total of 5 videos are provided:

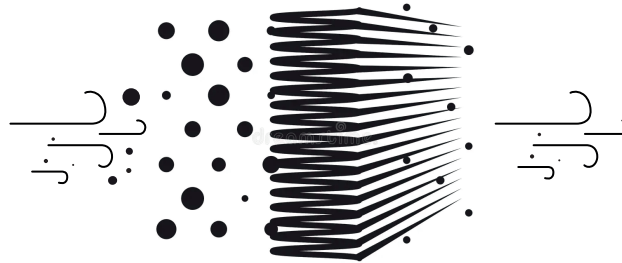
1. Introduction to Air Quality (There is no associated activity; you can discuss with the students after watching the video to see what they have understood).
2. Ozone (Activity: 'The Maze').
3. Particulate Matter (Activity: 'Surface Cleaning').
4. Volatile Organic Compounds (Activity: 'Sources of VOCs').
5. Carbon Dioxide (Activity: 'CO2 Concentration').

After watching each introductory video, if you wish, you can develop a more in-depth explanation and then proceed to carry out the associated activity related to that pollutant.

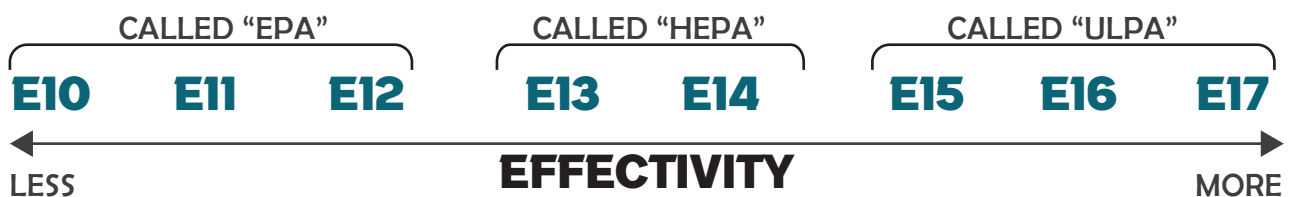
FILTRATION

Ventilation and filtration

As we have learned, it is essential to ventilate to maintain good indoor air quality. However, what happens when natural ventilation is not possible or when the outdoor air quality is poor for natural ventilation?

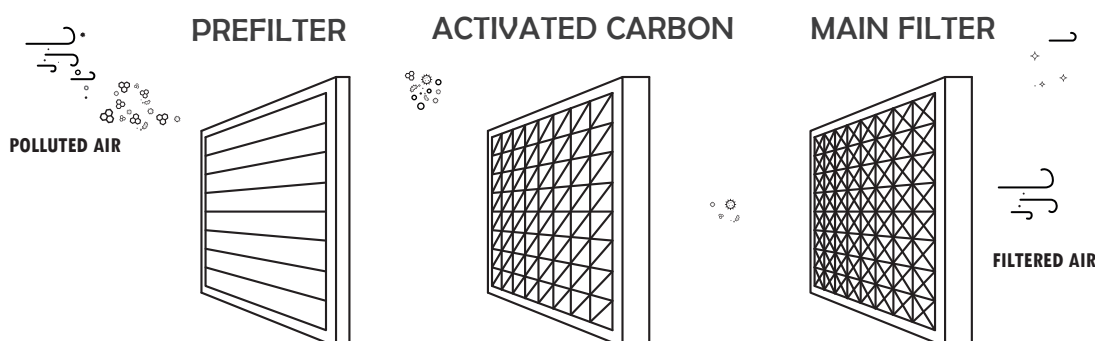


The purpose of filtration is to remove as many contaminants as possible from the ambient air. This process involves passing the air in a room through multiple filters several times, which are designed to trap the contaminants present in the air, retaining them as much as possible. There are different types of filters with varying degrees of filtration capacity.



The process

The most basic portable equipment that we can currently find on the market consists of a pre-filter responsible for trapping larger particles (such as dust, lint, pollen), an activated carbon filter tasked with adsorbing gases, odors, VOCs, and the filter (EPA, HEPA, ULPA), which is responsible for trapping smaller particles (viruses, bacteria, pollen, fungi, aerosols).



RECOMMENDATIONS

To improve IAQ

In general, to improve indoor air quality, we can take the following actions:

1. Share the information with our environment (family and friends) so that the network of knowledge and awareness expands.
2. It is essential to maintain both proper hygiene of indoor spaces and ventilation systems. As much as possible, avoid using air fresheners as an alternative to cleaning.
3. Ventilate the spaces during and after cleaning tasks.
4. Use masks if we are in spaces where there is a high concentration of people, especially if they are sick, elderly, or pregnant.
5. Use masks if we are in an indoor space and we know we have a contagious disease to prevent spreading the disease through the air

When there is poor IAQ

If we are aware of poor indoor air quality, some of the actions to take to improve it could be as follows:

1. Ventilate the space naturally or mechanically. If the space has windows and doors, open them to allow air to circulate.
2. If ventilation is not possible (or while the space is being ventilated), use masks (preferably FFP2 or FFP3) to avoid breathing the contaminants present in the air.
3. If the source of indoor air pollution is known, one possible solution is to remove the source from the space that is causing the contamination (for example, air fresheners, aerosols, printers, etc.).

OZONE

What is it?

Ozone (O₃) is a colorless and odorless gas that is naturally found in the stratosphere at about 8-15 km above the ground. When present at these heights, it is called stratospheric ozone or "Good" ozone because it protects us from the rays and ultraviolet radiation emitted by the Sun. However, it is also found at low levels in the atmosphere where we live, and it is called tropospheric ozone or "Bad" ozone because it is a highly oxidizing substance that causes damage to people and ecosystems.

In outdoor spaces, ozone is formed by the chemical reaction between other pollutants (such as NO_x, primarily from traffic) and sunlight. However, in indoor spaces, ozone is generated by the use of electrical devices such as photocopiers or laser printers.

Health Effects

Although ozone is a highly oxidizing gas and therefore capable of breaking down the proteins of viruses, making it a potent disinfectant, at tropospheric levels ('Bad' ozone), it can cause:

- Coughing and throat irritation.
- Inflammation of the respiratory tract.
- Worsening of asthma attacks.
- Cardiovascular diseases.

Among other conditions.

The Maze Activity

After watching the informative video, suggest to the students to complete the activity on page 13 of the activity workbook. It involves finding the correct path to the sources and effects of ozone. You can give them approximately 10-15 minutes to complete this activity. Afterwards, you can project the labyrinth on the board or have it printed on a larger format beforehand so that students can draw their path. If one is incorrect, another student can try.

VOLATILE ORGANIC COMPOUNDS

What is it?

VOLATILE ORGANIC COMPOUNDS (VOCs) are chemical substances (some of them toxic and carcinogenic) that are in a gaseous state in the air. They can be found in low concentrations outdoors, but indoors, where ventilation is often limited, concentrations can be up to 5 times higher.

Some of the products we use in our daily lives release VOCs into the air we breathe, such as perfumes, deodorants, air fresheners, or some cleaning products. VOCs are also emitted into the air by paints, varnishes, some materials used in furniture, or tobacco smoke.

Health Effects

The effects of VOCs on health depend on the duration of exposure and the type of compound. From short-term exposure to long-term exposure, VOCs can cause:

- Eye and respiratory tract irritation.
- Headaches, dizziness, fatigue, allergic reactions, or nausea.
- Liver damage.
- Kidney damage.
- Damage to the central nervous system.

The Sources of VOCs Activity

After watching the informative video, suggest to the students to complete the activity on page 16 of the activity workbook. The student should be able to identify the products that release VOCs into the air. You can give them about 10-15 minutes to complete this activity.

PARTICULATE MATTER

What is it?

Particulate matter is a mixture of solid and liquid particles suspended in the air. It is one of the most dangerous pollutants for human health. Particulate matter has a diverse composition (including metals or organic compounds, among others) depending on its emitting source and the size of the particle itself.

The sources are very varied, but it is common for particulate matter to be generated due to combustion processes, or the use of wood or pellet stoves, or gas. It can also come from tobacco and electronic cigarettes, candles, incense, and even from dust deposited on floors and furniture.

It is classified according to the size of its particles into: fine particulate matter (PM_{2.5}) and coarse particulate matter (PM₁₀).

Health Effects

Inhalation of particulate matter poses health effects even at very low concentrations. No threshold has been identified below which no health damage has been observed. The smaller the particles, the more dangerous they become as they can reach the bronchioles, alveoli, and bloodstream, causing:

- Respiratory diseases (asthma, bronchitis, or lung cancer).
- Cardiovascular diseases.
- Diseases of the central nervous system.

The Surface Cleaning Activity

After watching the informative video, suggest to the students to complete the activity on page 14 of the activity workbook. Particulate matter settles on the surfaces of the objects around us. By analyzing surface cleaning, it is possible to visually identify the concentration of PM at different heights and locations. For sampling, a cotton ball moistened with water will be used. After sampling, the student will fill in the data according to the level of contamination found at each height of the analyzed surfaces.

CARBON DIOXIDE

What is it?

Carbon dioxide (CO₂) is a chemical compound that under normal conditions exists as a gas. Its main source comes from the respiration of human beings, as we exhale carbon dioxide when we breathe, but it is also released in combustion processes.

Carbon dioxide is not considered an air pollutant, but it serves as an indirect indicator of the presence of aerosols, particles, viruses, or bacteria in the air we breathe. Therefore, it helps us estimate the potential risk of airborne disease transmission in indoor spaces with human occupancy.

A little more about CO₂...

The concentration of CO₂ in outdoor environments is usually stable and typically around 420 ppm (parts per million). The recommended concentration values for carbon dioxide in indoor environments are established at:



>1200 PPM



>800 PPM



<600 PPM

The greater the number of people, the higher the concentration of carbon dioxide in an unventilated space. To assess the efficiency of ventilation in indoor environments, a good option is monitoring the level of carbon dioxide (CO₂).

It is essential to ventilate indoor spaces to ensure adequate levels of health for the occupants. The options for properly ventilating an indoor space, ranked from least optimal to most optimal, would be as follows:

1. Natural ventilation (intake and exhaust through windows and doors).
2. Air intake through natural ventilation + mechanical exhaust.
3. Intake with filtration and mechanical exhaust.
4. Intake with filtration and mechanical exhaust + heat recovery.

Health Effects

Inhaling carbon dioxide indoors (below 5,000 ppm) can cause:

- Headache, fatigue, sore throat, eye irritation, or cough.
- Negative cognitive effects (decreased concentration ability).
- Decrease in blood pH.
- Variability in heart rate or increase in blood pressure.

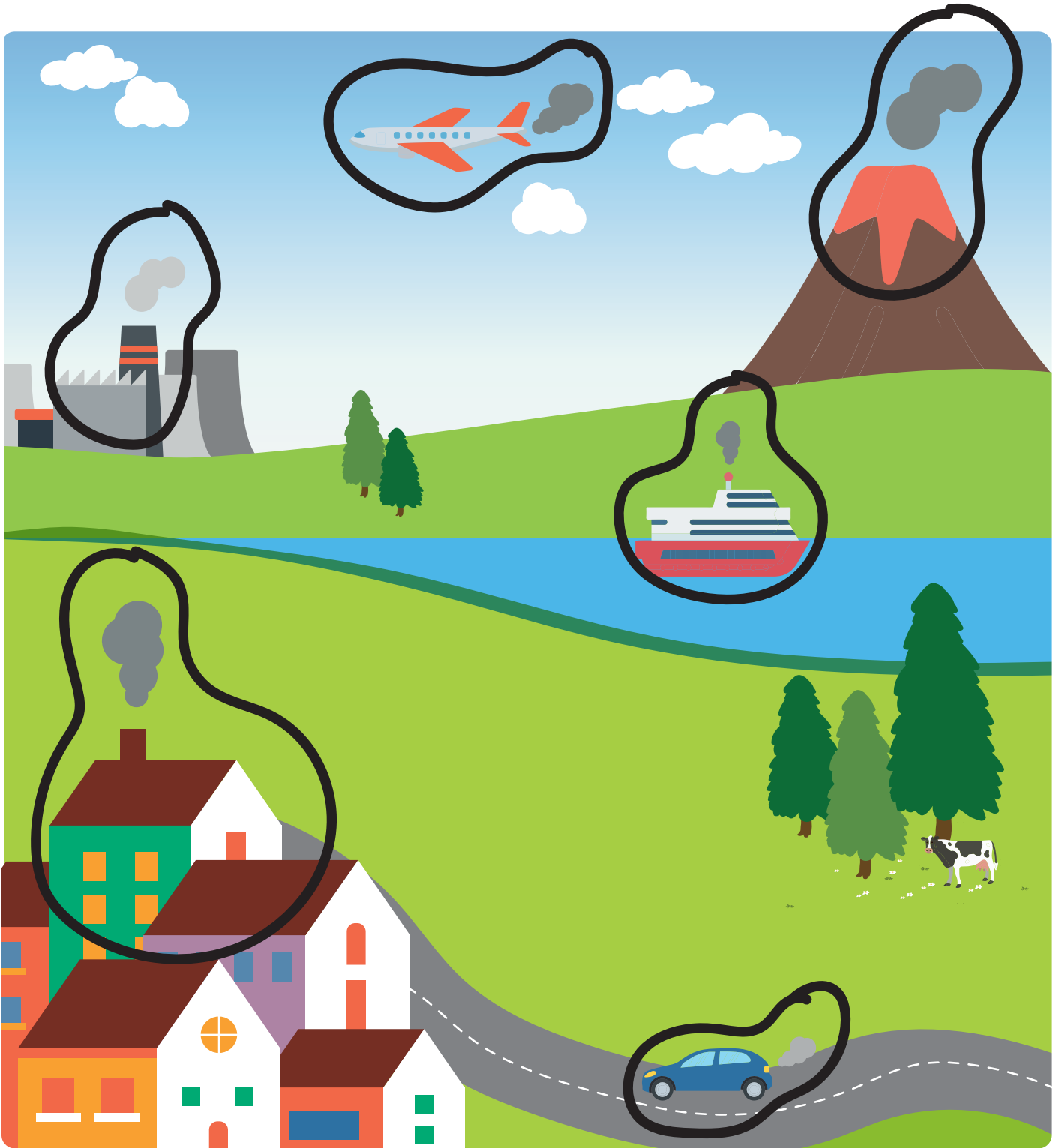
The CO₂ Concentration Activity”

After watching the informative video, suggest to the students to complete the activity on page 17 of the activity workbook. The concentration of CO₂ in indoor environments should be regulated through the use of ventilation (natural, mechanical extraction, or supply and mechanical extraction).

In environments occupied by humans where there is no proper ventilation, CO₂ levels can skyrocket within minutes. Imagining that the indoor spaces shown in the activity images do not have any type of ventilation, students should estimate what CO₂ concentrations are associated with each space.

OUTDOOR SOURCES

There are various sources of outdoor air pollution; let's see if you can identify them. Look at the drawing and think about which external sources of pollution are present in the image, then point them out/circle them. Remember that there are both natural and artificial sources of pollution.



RESEARCH ONE POLLUTANT

There are many pollutants that affect the quality of our air we breathe. Individually or in groups choose one type of pollutants to research it.

Try to have each group/student research a different pollutant. Let him use online resources to do research. An optimal time for searching for information could be 20 minutes. As this time passes, ask them to share their findings with the rest of the class.

Try to ensure that when researching the alternative country there is a difference between them. For example, you can propose, for example, India, China or the United States (large countries with a lot of outdoor air pollution) compared to Luxembourg, Denmark or Switzerland (with less outdoor air pollution according to

Name of pollutant

WHERE IS COME FROM?

HEALTH EFFECTS

UPPER LIMIT VALUES IN YOUR COUNTRY

AND IN ANOTHER COUNTRIES?

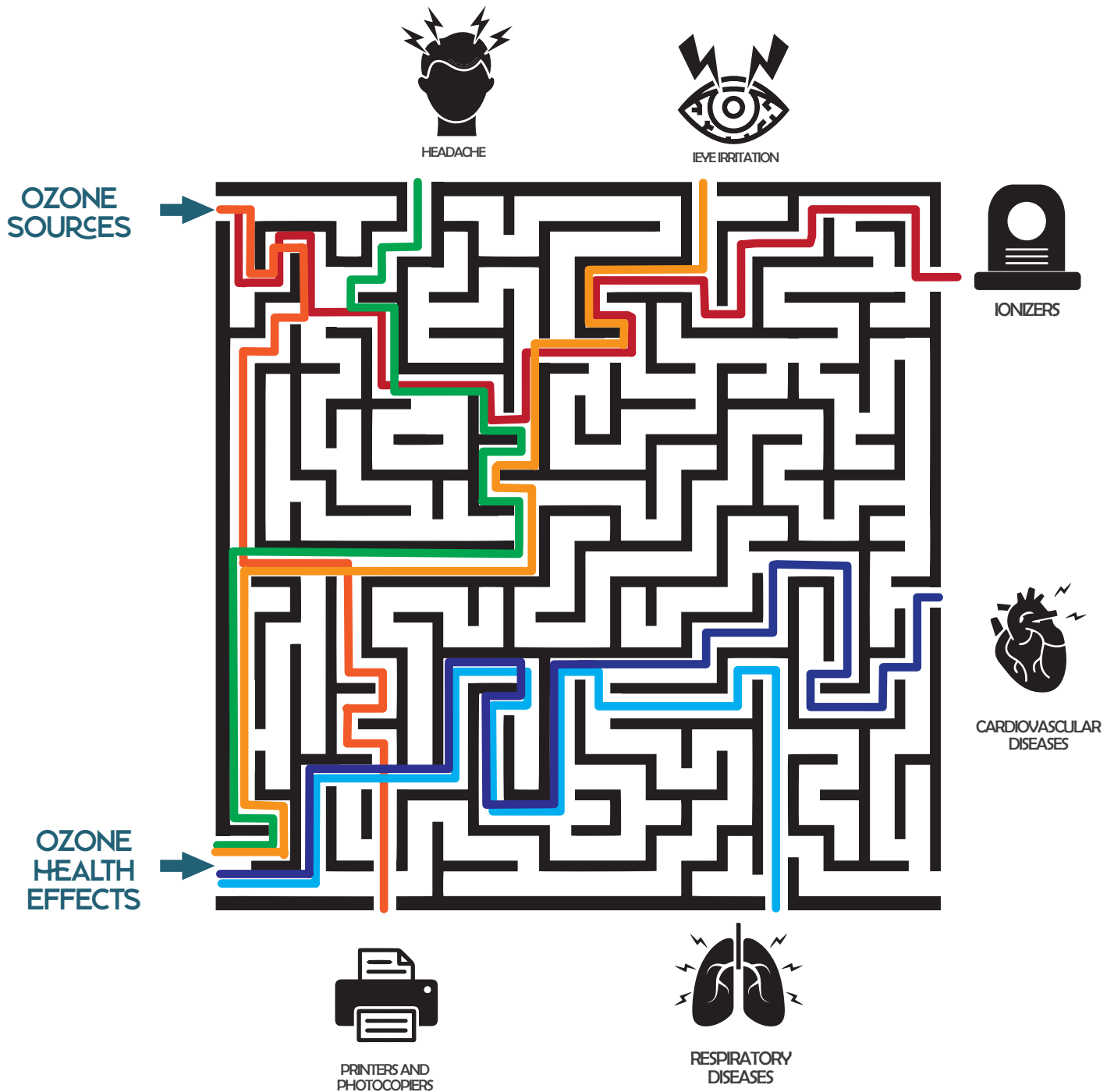
SOLUTIONS/RECOMMENDATIONS TO IMPROVE THE POLLUTION

WHY NOT DESIGN A POSTER WITH THIS INFORMATION TO DISPLAY TO WHOLE SCHOOL?

THE MAZE

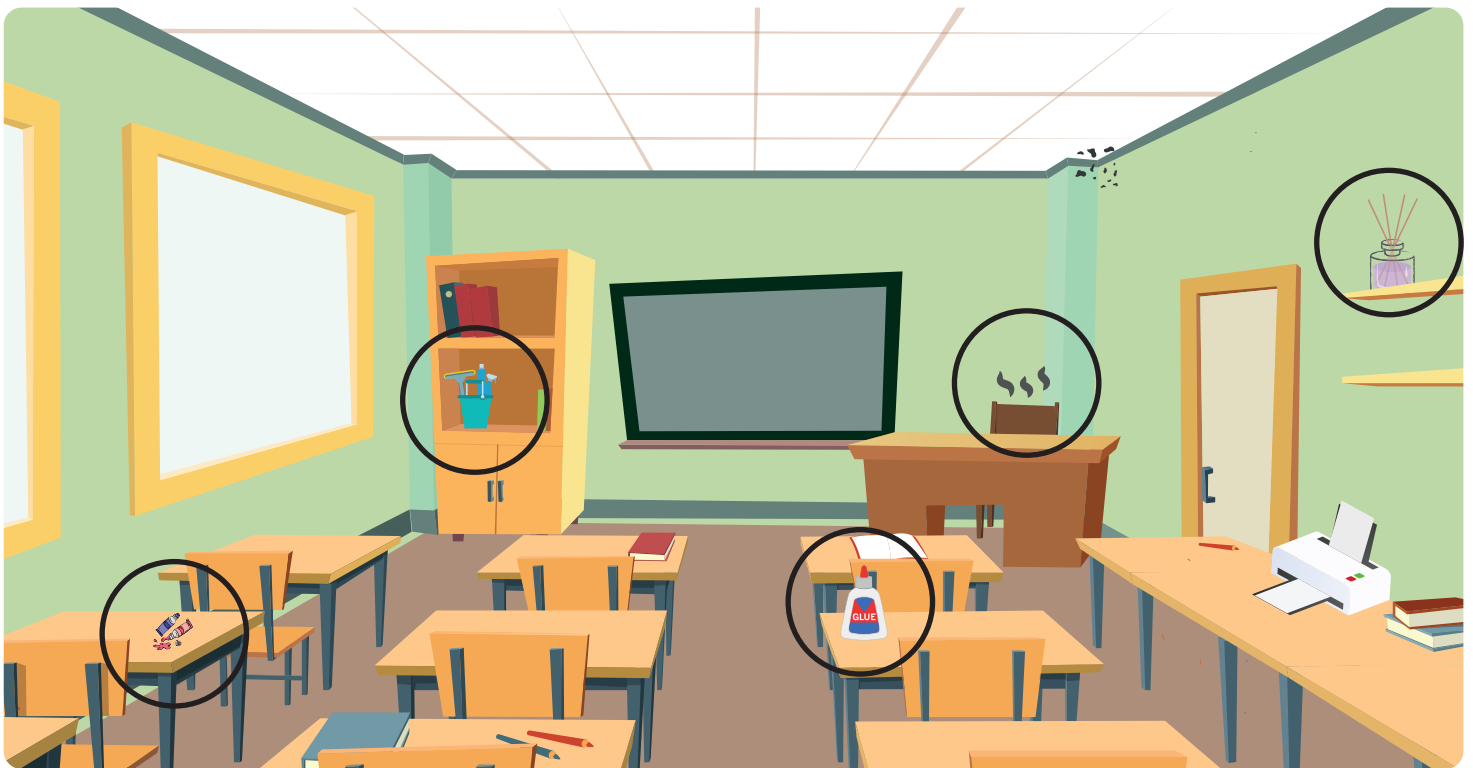
As we have learned, ozone causes different negative effects on our health and comes from different sources. Would you be able to find the correct path to the effects and sources?

Let's go!



SOURCES OF VOCs

As we have learned, many of the products we use in our daily lives emit VOCs into the air we breathe. Would you be able to find the 5 elements that contaminate indoor air by emitting VOCs?



Cleaning products: Those that are ecological and are also “fragrance-free” release less.

Fornitures: Some finishes, adhesives and varnishes furnitures are a major source of indoor air pollution.

Glue and Paint: It releases toxic chemicals emitted by paints while they are drying.

Air freshener: This everyday product can release hundreds of dangerous volatile organic compounds.

SURFACE CLEANING




Through this activity, we are going to learn about the amount of particulate matter present in our surroundings. The particulate matter in the air settles on the surfaces of the elements around us.

Pollution Level



Take the cotton balls dampened with water. Collect samples from various elements at different heights such as walls, doors, or furniture. Simply drag the cotton ball across the surface of the element as if you were cleaning it.

Surface 1: Door / Wall / etc.

HEIGHT	PASTE YOUR SAMPLE HERE	LEVEL 1-5
 90 cm	In this space, the student must stick the collected sample at the height indicated by the column on the left.	4
 60 cm	Depending on how "dirty" the cotton comes out, the student should put a number in the left column.	2
 30 cm		1

CARBON DIOXIDE LEVEL

As we already know, humans exhale carbon dioxide when we breathe. That's why, the greater the number of people in an indoor space, the higher the concentration of this gas will be.

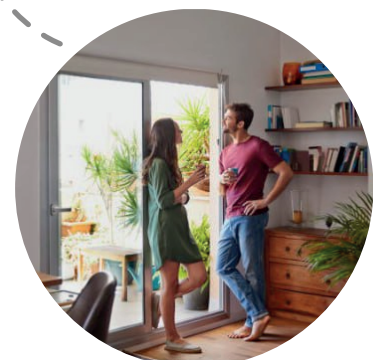
We also know the recommended concentrations of CO₂ in indoor spaces. Would you be able to guess at what concentration levels you think there would be in these indoor spaces if there were no ventilation?



>1200 PPM

>800 PPM

<600 PPM



WORD SEARCH

Identify the pollutants

Would you be able to find the 10 types of indoor air pollutants hidden in this word search? Give it a try!

I	P	M	R	I	U	X	N	J	F	U	Y	S	M
D	T	O	B	A	C	C	O	E	P	O	L	V	O
U	Q	T	M	A	D	H	L	V	F	K	F	L	H
S	E	W	O	O	C	A	Z	P	I	A	O	I	D
T	M	P	R	E	S	O	R	A	H	M	R	C	L
S	G	W	A	J	C	K	L	E	N	B	M	O	E
P	C	C	M	M	D	O	C	O	X	I	A	N	N
F	H	T	I	E	O	I	L	H	G	E	L	P	C
C	A	I	R	F	R	E	S	H	E	N	E	R	E
M	L	Z	C	T	A	A	I	J	B	T	E	I	N
O	K	A	B	A	N	W	N	A	I	A	H	N	O
L	S	E	Q	D	E	O	D	O	R	A	N	T	I
D	L	V	S	I	E	U	M	M	H	O	D	E	L
V	D	B	N	E	S	C	A	N	N	N	E	R	N

1. AIR FRESHENER

2. PRINTER

3. SCANNER

4. DEODORANT

5. DUST

6. MOLD

7. COLOGNE

8. TOBACCO

9. CHALK

MAKE YOUR OWN FILTER

We already know the importance of filtering indoor air, but HEPA air purifiers can be expensive, making them inaccessible to everyone. That's why, prompted by the situation caused by the COVID-19 pandemic, in 2020, Richard Corsi (an environmental engineer and Dean of Engineering at the University of California, Davis) came up with the idea of combining air filters with a square fan to improve the efficiency of air purifier designs with the goal of reducing levels of small particles that can transmit viruses through the air indoors.

Although it was designed with the aim of preventing airborne virus transmission turned out to be an air purifier that can be built by anyone at a low cost.

Currently, this design has evolved into the Comparetto cube, which utilizes four filters and a cardboard base, making it possible to place directly on the floor. Subsequently, a cardboard cover was incorporated to shield the corners of the fan, thereby enhancing its efficiency.

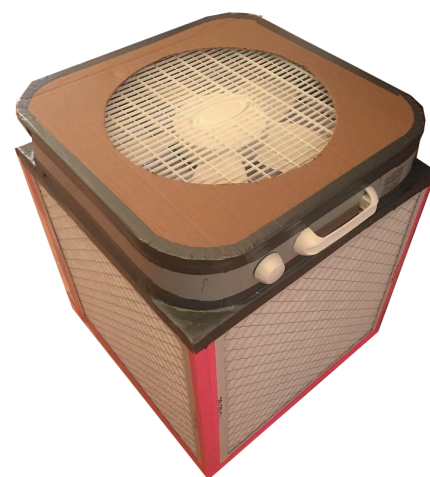
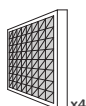


Image extracted of WIKIPEDIA

Ask them to notice the color of the filters and turn them on in class. When a few days have passed, see how the filter has changed color as it has trapped the contaminants from the indoor air.

Materials



MERV-13 AIR FILTERS
20 x 20 x 2 cm



BOX FAN



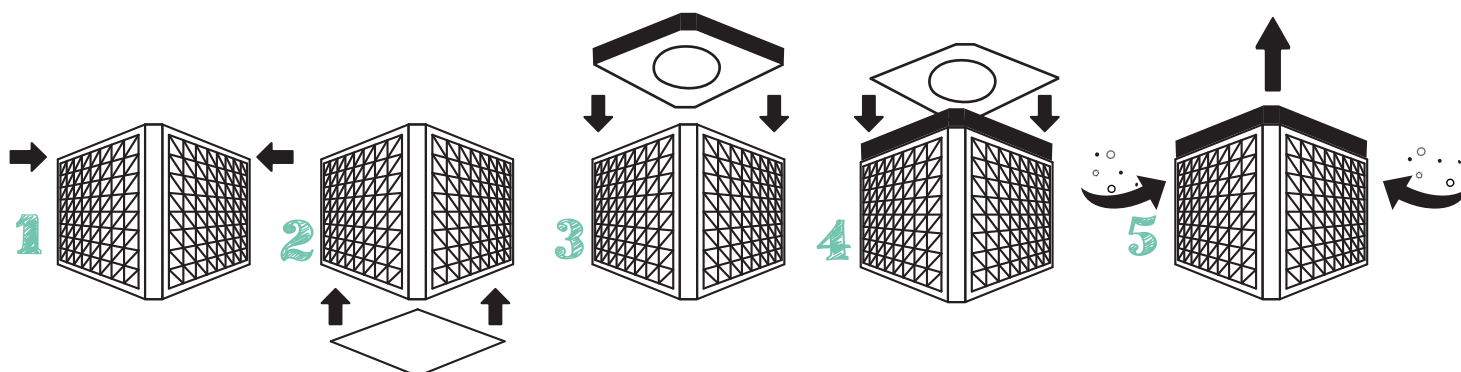
SQUARE FAN BOX OR OTHER



SCISSORS AND ROLL TAPE

Steps

- 1 Making sure the air flow arrows point inward, align the corners of two air filters. Secure the corners with tape and repeat with the other filters to create a box shape.
- 2 Flip over your box and attach your large cardboard square to the bottom with long strips of tape that cover the length of each side.
- 3 Flip your box back over. Now you can place your box fan on the top of the cube. You want the fan to be blowing air out of the box. Tape each side of the fan, making sure to cover any holes between the box and the fan.
- 4 Place your four or one cardboard piece/s on the inner corners of your box and secure them with tape.
- 5 DONE! Now you can turn on the fan and now you have an air filter! The contaminated air will enter through the sides where the filters are located, and will be filtered out through the top.



MAKE YOUR OWN POSTER

Now It's time to tell everyone what you have learned! Create a poster to tell the whole school how the air gets polluted, the main sources of pollution, and some recommendations that can be implemented to improve indoor air quality. Use any materials you want!

You can do this activity in class or at home. At the end, ask them to briefly explain what they wanted to convey with the poster. Later, stick it on the wall (in an area where there is student traffic) so that the rest of the school can see and read the information.

Some tips...

1. Write large titles

Remember that a title grabs attention, so others will come to see your poster because they will be interested.

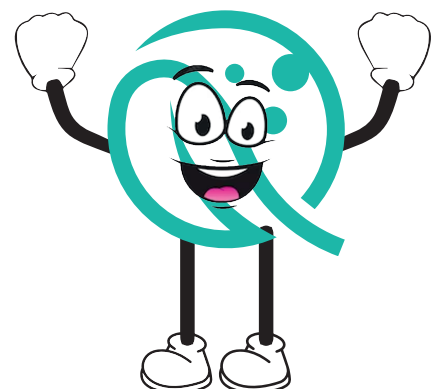
2. Include drawings

It's important that the poster explains what you have learned, and there's no better way to do this than through drawings.

3. Write information

You can make a poster explaining everything you have learned or focus on an aspect that caught your attention (for example, sources of pollution, types of pollutants, or recommendations to improve indoor air quality).

STICK IT ON THE WALL FOR EVERYONE TO SEE!





EVIDENCE DRIVEN INDOOR AIR QUALITY IMPROVEMENT



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