



## Lesson insert 2: Monitoring air pollutants Presenters' guide

### Aim

The aim of this lesson insert is for students to investigate the composition of the air beyond gases. Students will learn the key pollutants in poor air quality and study historical air pollution data in CDMX over the past 20 years.

### Equipment

- One worksheet per 2 students (recommended). There are 15 worksheets in total so depending on number of students some students might have to work on their own.
- Lesson insert 2 PowerPoint slides

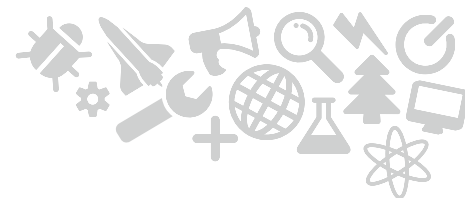
### Preparation

You will need time to print the worksheets linked with this lesson insert and evaluation materials. More information regarding evaluation materials can be found at the end of this document.

### Curriculum links across all the MANAPRE educational resources

Our lesson inserts have been designed with links to the national curriculum. The list is not extensive and we are keen to work with teachers and presenters to make these links clearer and more comprehensive.

Subject	Level	Link
Geografía	Secundaria 1	<b><i>Medioambiente y sustentabilidad</i></b> Analiza la relación entre el deterioro del medioambiente y la calidad de vida de la población en diferentes países.
Química	Secundaria 3	<b><i>Propiedades</i></b> Caracteriza propiedades físicas y químicas para identificar materiales y sustancias, explicar su uso y aplicaciones.
Química	Secundaria 3	<b><i>Ecosistemas</i></b> Argumenta acerca de las implicaciones del uso de productos y procesos químicos en la calidad de vida y el medioambiente.
Matemática	Secundaria 1	<b><i>Estadística</i></b> Recolecta, registra y lee datos en tablas; usa y interpreta moda, media aritmética y mediana.



## Introduction [7 minutes]

**NOTE:** Please give your student the pre-evaluation questionnaire ahead of this lesson. More details regarding evaluation can be found at the end of this document.

## Air and the atmosphere

Begin by splitting the room into pairs of students. Give students 1 minute to discuss what is air made of. Shows them the slide with the different gases in air until you reach to the rest. The rest (0.03%) contain traces of other gases such as neon, helium.

The Earth's atmosphere contains all of the gases in air, but also water vapour (which varies locally and seasonally). There are also air pollutants.

Air pollutants are by definition any solid, liquid (and some gas) particles which are suspended in air and therefore contaminate the atmosphere and the air we breathe.

## Sources of and Sectors contributing to air pollution

Both natural processes (such as volcanic eruptions) or human activity (burning of fossil fuels) can generate air pollution. For instance, pollen released by trees is an example of a natural air pollutant. Nitrogen Dioxide ( $\text{NO}_2$ ) is a by-product of burning petrol and therefore is increased by human activity. According to the European Environment Agency (EEA) summarises some of the sources contributing to air pollution in Europe as:

- natural sources, including volcanic eruptions, windblown dust, sea-salt spray and emissions of volatile organic compounds from plants
- burning of fossil fuels in electricity generation, transport, industry and households;
- industrial processes and solvent use, for example in the chemical and mining industries;
- agriculture;
- waste treatment;

Therefore, sectors associated with air pollution are:

- Industry & Energy supply
- Transport
- Waste management
- Agriculture
- Household energy



**TIP:** If you are looking for infographics to display around your classroom around the topic of air pollution, the World Health Organisation (WHO) has a collection available [here](#).

## **Air pollution TRAVELS everywhere**

Because our planet has a rich and dynamic atmosphere, air pollutants travel across the world by weather patterns and ocean currents. The video [A Year in the Life of Earth's](#), created by NASA, shows how Carbon Dioxide (CO<sub>2</sub>) sources are dispersed by the dynamics of the atmosphere. This is one of the reasons why air pollution is a global problem and every country must work together to lessen air pollution sources. The idea of air pollution being a global problem which can be tackled by individual citizens is further developed at the end of this lesson insert.

## **Pollutants increased by HUMAN ACTIVITY**

There are many pollutants increased by human activity. On this slide we present some examples of air pollutants according to their state of matter: gases such as Carbon Monoxide, solid such as lead but also an important category of air pollutants designated by particulate matter or PM. We will explore PM further throughout the rest of this lesson insert. You can find additional information regarding the most relevant air pollutants in [CDMX Air webpage](#).

## **Particulate Matter PM**

As mentioned particulate matter (PM) is a complex class of air pollutants which encompasses solids and liquids suspended in air. PM varies in size, composition and origin. A good way of classifying PM is according to their sizes:

- PM<sub>1</sub> - refers to particles smaller than 1 micron
- PM<sub>2.5</sub> - refers to particles smaller than 2.5 microns
- PM<sub>10</sub> - refers to particles smaller than 10 microns

By comparison the average diameter of a human hair is about 70 microns.

Particulate matter affects people more than any other air pollutant as PM<sub>10</sub> and PM<sub>2.5</sub> can penetrate deep inside our airways and cause health problems. There are reasons to believe that PM<sub>1</sub> can reach deepest into lungs and also cause health impacts.

## **Who studies air quality? – STEM person of the week**

Elizabeth Vega is one of the scientists featured in our *STEM Person Of The Week – Who studies air pollution* resource, which is a 5 week intervention in schools designed to broaden students' perceptions of people working in STEM and their attributes. If you are running this intervention in parallel we recommend to align



the STEM person of the week with the one featured in this resource. For more information please refer to our presenter's guide 4.

There are several people studying air quality such as Elizabeth who is an Environmental scientist keen to study sources of air pollution from samples of dust or rainfall.

## Activity [15 minutes to complete the worksheet ]

### ***Monitoring PM<sub>10</sub> levels in CDMX***

Particulate Matter, PM, affects more people than any other air pollutants. This is why PM<sub>10</sub> is one of six air pollutants which are constantly being measured by a network of monitoring stations across CDMX.

PM<sub>10</sub> is measured in units of mass per volume, more explicitly in *micrograms per cubic metre*. The recommended limit of PM<sub>10</sub> measured over a period of 24-hours has a mean value of 75  $\mu\text{m}/\text{m}^3$ .

For this activity we ask your students to investigate two questions.

### ***1. Monitoring PM<sub>10</sub> levels in CDMX and Air Quality Index***

Students will access PM<sub>10</sub> historical data measured in three locations across CDMX: Merced (MER), Pedregal (PED) and Vila de las Flores (VIF).

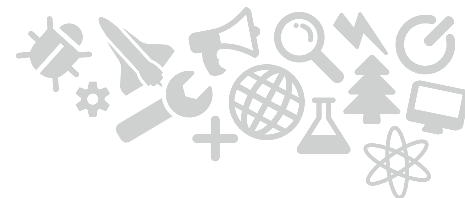
The dataset refers to the first 7 days of April of the years 2000, 2005, 2010, 2015 and 2020.

The values correspond to the PM<sub>10</sub> 24 hours means for the dates above mentioned.

### ***Task 1: AQIs***

The data collected by monitoring stations is used to inform citizens about the quality of air using an Air Quality Index (AQI). The different AQI relates to the PM<sub>10</sub> 24 hours mean value as per below:

Air Quality Index	PM <sub>10</sub> VALUE in $\mu\text{m} / \text{m}^3$
Good	0 to 50
Acceptable	50 to 75
Unhealthy	75 to 155
Very unhealthy	155 to 235
Extremely unhealthy	over 235



For example if a station measures a mean value of **PM<sub>10</sub> = 10 µm / m<sup>3</sup>** then the Air Quality Index is **Good**.

For this task the students are invited to complete the Air Quality Index column for the first 7 days of April using the information on the table.

DATE	PM <sub>10</sub> VALUE in µm / m <sup>3</sup>	Air Quality Index
01 APR	80	Unhealthy
02 APR	92	Unhealthy
03 APR	79	Unhealthy
04 APR	47	Good
05 APR		
06 APR	---	
07 APR	---	
<b>MEAN</b>	<b>74.5</b>	

**TIP:** Sometimes monitoring stations need maintenance or breakdown, so students may not have data for all of the days

## Task 2: PM<sub>10</sub> weekly means

Students need to calculate the weekly mean value of the PM<sub>10</sub> over the 7 days and complete the their table.

## 2. How levels of PM<sub>10</sub> have changed in the past 20 years in CDMX ?

The network of monitoring stations across CDMX has been measuring the levels of PM<sub>10</sub> for over 20 years. Analysing this data will helps your students to understand how effective some measures are in creating cleaner air for everyone

## Task 3

Students need to copy across their weekly mean and write it on the correspondent box of the table below



YEAR	MEAN in $\mu\text{m} / \text{m}^3$
2000	74.5
2005	97.3
2010	71.6
2015	52.1
2020	47.6

#### Task 4: Collecting PM10 weekly means across the years

NOTE: this task will involve students talking to each other to gather information from each; expect disruption across the classroom

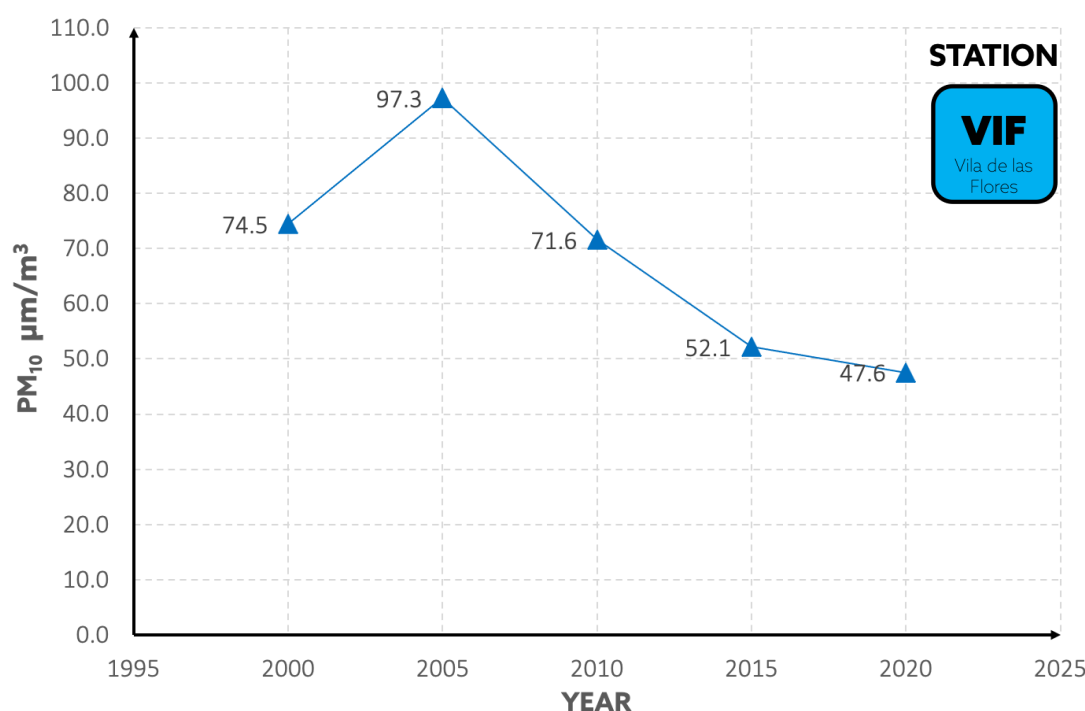
Students needs to find out who in their classroom has calculated the 7-days **MEAN** values for the same station but in different years. This will help them to complete their table as show above for VIF.

**TIP:** All 3 stations are colour coded: MER (green), PED (red) and VIF (blue) so you could regroup students according to their station.

#### Task 5: Plotting historical data

For this task we ask students to plot their data as a visual aid for comprehending how  $\text{PM}_{10}$  levels have changed across 20 years (increased or decreased) and to suggest what might have caused these changes.

As an example, the graph regarding VIF would look as follows:



**TIP:** If you are short for time then you can simply ask students to contribute with their weekly means whilst navigating through slides on the wrap up activity.

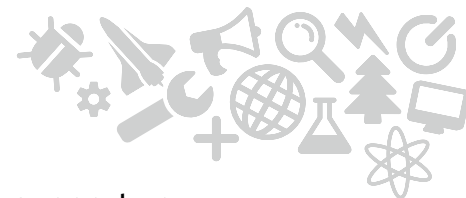
**NOTE:** This task should be seen as a proxy of what the true variation of PM<sub>10</sub> across a period of 20 years. It would be very time consuming to ask students to calculate 20 annual averages each linked with potential 365 data set. A weekly mean sample across 5 years has its limitation for interpretation but provides sufficient information to determine whether or not PM<sub>10</sub> levels have declined across these 3 locations.

**Task 6:** The worksheet ends with asking students for suggestions of what can be done to help reduce the levels of PM<sub>10</sub> over the next 5 years. Students can think about who can implement these in the following categories:

- Industry & Energy supply
- Transport
- Waste management
- Agriculture
- Household energy

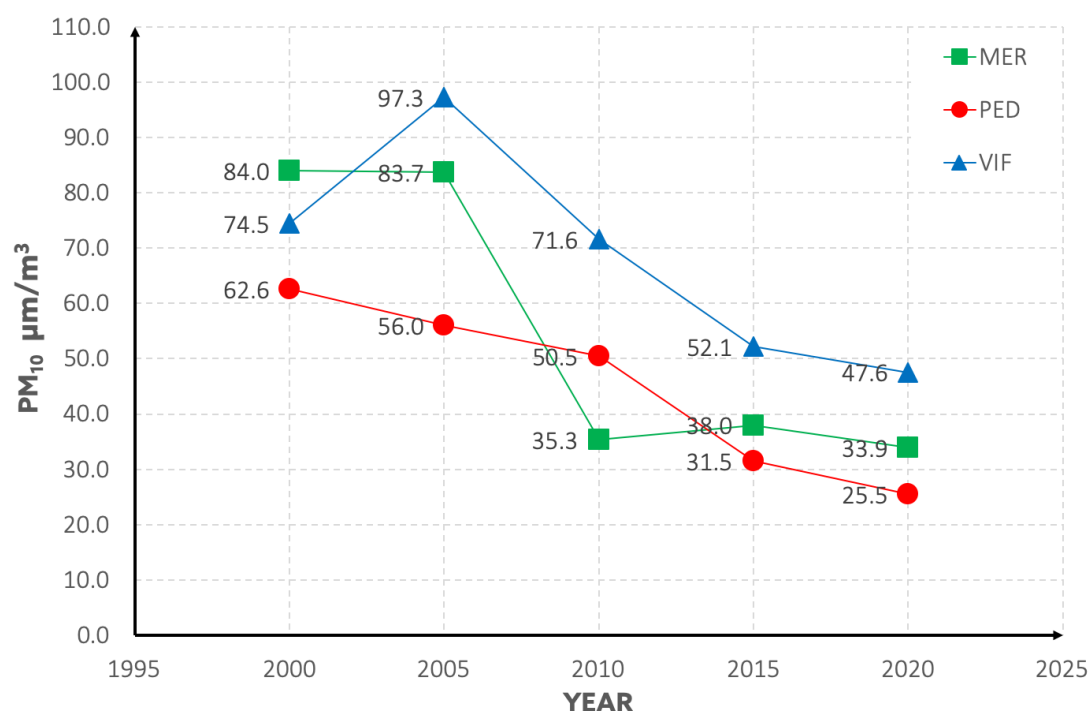
## Wrap up activity [5 minutes]

Once your students complete their worksheets we suggest you to present the slides with the graphs showing the PM<sub>10</sub> weekly means across the years. A



summary of the data is presented below and could be used to support your students with their independent calculations.

	2000	2005	2010	2015	2020
MER	84.0	83.7	35.3	38.0	33.9
PED	62.6	56.0	50.5	31.5	25.5
VIF	74.5	97.3	71.6	52.1	47.6

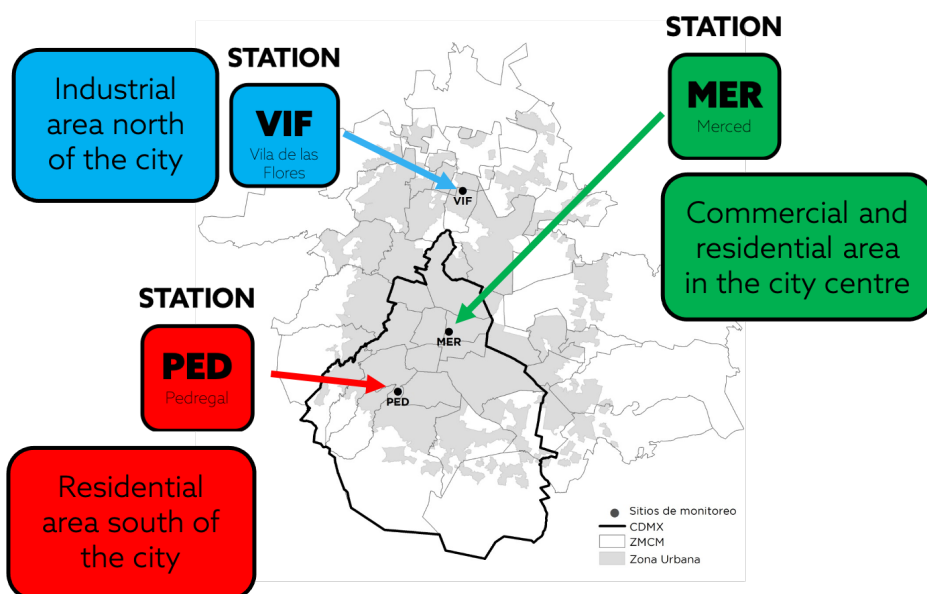
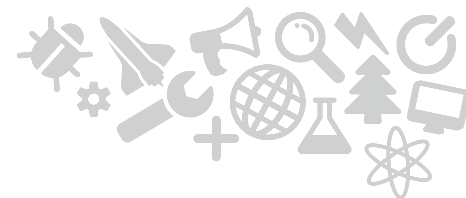


We suggest exploring the following questions with your students:

*How did the PM<sub>10</sub> levels changed over 20 years?*

This should be based on the interpretation of the graph created by your students and presented by you in the classroom; you could ask students if they think all the 3 locations show the same trend across the years, and potentially what is different about these areas of CDMX. Here is reminder of the different areas being monitored:



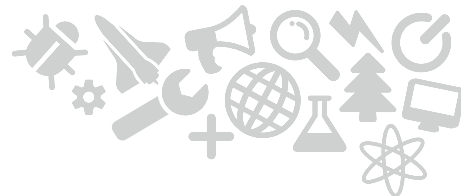


Why did the  $PM_{10}$  levels changed over 20 years?  
Can you predict what the levels of  $PM_{10}$  will be in 2025?

To stimulation discussion around these 2 questions we suggest students to revisit their suggestions for Task 6.

A good summary of the efforts taken by the authorities in CDMX over the past 25 years in order to reduce air pollution can be found in [report](#) published by the Secretaria del Medio Ambiente (SEDEMA) (see page 59). It's worth highlighting from this report:

- *La calidad del aire ha mejorado significativamente en la Ciudad de México en los últimos 25 años.*
- *Las mejoras en la calidad del aire han salvado 22,000 vidas, principalmente por las reducciones en las concentraciones de  $PM_{2.5}$ .*
- *A pesar de las mejoras en la calidad del aire, los niveles actuales aún se encuentran por arriba de aquellos que representan riesgos para la salud.*
- *Una de las principales fuentes de emisión de  $PM_{2.5}$  son los vehículos pesados a diésel.*
- *Habitantes de la Ciudad de México viven en promedio 3.2 años más gracias a las mejoras en la calidad del aire.*



- *Ozone levels also need to be addressed.*

## **Lesson insert wrap up [3 minutes]**

### **Air pollution and Sustainable Development Goals (SDGs)**

As air pollution is a global problem, countries need to work together on solutions for reduce the sources of air pollution, especially those linked with human activity. Examples of these global solutions are:

- addressing sustainable transport
- more efficient and renewable energy production
- better use and waste management.

Addressing air pollution is part of the Sustainable Development Goals number 11, which is one of 17 goals aimed at making the world a better place by 2030.

The goals have been agreed by members of the United Nations (UN). The SDGs should enable young learners to see themselves as global citizens and engage with opportunities to take action for sustainable development at schools, local communities and beyond.

CLEAR AIR FOR ALL! Everyone is responsible, everyone can help, is the common message across all of the MANAPRE educational resources and good call for action for you and your students to think about what can they do to tackle air pollution.

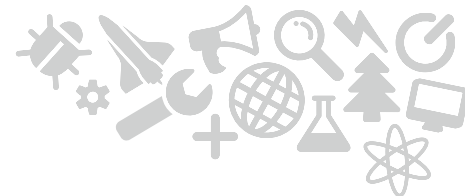
## **Extension**

### **In and around school**

The Global Centre For Clean Air Research based at the University of Surrey has published a child friendly report for students, teachers and schools with recommendations of how to [mitigate exposure to traffic pollution in around schools](#). It is worth exploring this document with your students against their suggestions on task 6 of the worksheet.

### **Loan portable air quality monitoring station for school**

Teachers can request to loan a portable air quality monitoring station to use in school. Further information in how to request these can be found in the MANAPRE website.



## Further reading:

*List of recommended sources of information for teachers and presenters keen to learn more about air quality and used across all the MANAPRE educational resources*

*WHO health impacts of air pollution overview*

[https://www.who.int/news/item/02-05-2018-9-out-of-10-people-worldwide-breathe-polluted-air-but-more-countries-are-taking-action#:~:text=Air%20pollution%20levels%20remain%20dangerously,outdoor\)%20and%20household%20air%20pollution](https://www.who.int/news/item/02-05-2018-9-out-of-10-people-worldwide-breathe-polluted-air-but-more-countries-are-taking-action#:~:text=Air%20pollution%20levels%20remain%20dangerously,outdoor)%20and%20household%20air%20pollution)

*SEDEMA health benefits of reducing air pollution in CDMX*

<http://www.data.sedema.cdmx.gob.mx/beneficios-en-salud-por-la-mejora-de-la-calidad-del-aire/descargas/analisis-espanol.pdf>

*Mitigating Exposure to Traffic Pollution in and around schools*

[http://epubs.surrey.ac.uk/857127/1/4564\\_Brochure%20%28FINAL\\_All%29.pdf](http://epubs.surrey.ac.uk/857127/1/4564_Brochure%20%28FINAL_All%29.pdf)

*Sustainable Development goals for teachers*

<https://oxfamlibrary.openrepository.com/bitstream/handle/10546/620842/edu-sustainable-development-guide-15072019-en.pdf?sequence=4#:~:text=The%20SDGs%20are%20a%20set,the%20world%20a%20better%20place.&text=The%20SDGs%2C%20also%20known%20as,protect%20the%20climate%20and%20environment.>

## Evaluation toolkit

The MANAPRE educational resources were created under an evaluation framework which help presenters to quantify changes in students' knowledge and appreciation of air quality. The evaluation is easy to implement and explained below. All the forms are available online and any evaluation collected should be sent electronically to [nustem@northumbria.ac.uk](mailto:nustem@northumbria.ac.uk).

## Student pre and post questionnaires:

These we design to collect a baseline information of knowledge and appreciation of the subject. The pre questionnaire should be given to students ahead of any delivery and *is independent of the number of activities you choose to deliver to your students*. In a similar way the post questionnaire should be given to your students after all the MANAPRE activities you choose to deliver.



**Before we start...**

How much do you agree with the following statements?

(please circle one face on each row only)

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1 I know what air pollution is	☹	☹	☹	☹	☹
2 I understand how air pollution can impact our health	☹	☹	☹	☹	☹
3 I know how I can help tackle air pollution	☹	☹	☹	☹	☹
4 I know how to measure air quality	☹	☹	☹	☹	☹
5 I think environmental science is interesting	☹	☹	☹	☹	☹
6 I know some different jobs in environmental science	☹	☹	☹	☹	☹
7 People who work in environmental science have exciting jobs	☹	☹	☹	☹	☹
8 I am interested in protecting the environment	☹	☹	☹	☹	☹
9 I would like to find out more about air pollution	☹	☹	☹	☹	☹

First letter of your first name	Favourite food	Favourite animal	Favourite colour	Boy or Girl?

**nustem**

**And finally...**

How much do you agree with the following statements?

(please circle one face on each row only)

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1 I know what air pollution is	☹	☹	☹	☹	☹
2 I understand how air pollution can impact our health	☹	☹	☹	☹	☹
3 I know how I can help tackle air pollution	☹	☹	☹	☹	☹
4 I know how to measure air quality	☹	☹	☹	☹	☹
5 I think environmental science is interesting	☹	☹	☹	☹	☹
6 I know some different jobs in environmental science	☹	☹	☹	☹	☹
7 People who work in environmental science have exciting jobs	☹	☹	☹	☹	☹
8 I am interested in protecting the environment	☹	☹	☹	☹	☹
9 I would like to find out more about air pollution	☹	☹	☹	☹	☹

First letter of your first name	Favourite food	Favourite animal	Favourite colour	Boy or Girl?

**nustem**

## Lesson insert learning feedback

These are quick evaluation postcards to give to your students at the end of the each lesson insert (except lesson insert 4). They were designed to gather information regarding enjoyability of the activities and any to identify any immediate subject knowledge enhancement but also to recognise any misconceptions.

**Workshop Review**

What can be found in air pollution besides gases?

How many stars would you give this workshop?

☆☆☆☆☆

**nustem**

**Workshop Review**

Has air quality improved in CDMX over the past 20 years?

How many stars would you give this workshop?

☆☆☆☆☆

**nustem**

**Workshop Review**

How can air pollution affect health?

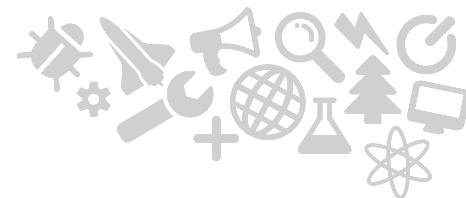
What new thing did you learn in today's workshop?

How many stars would you give this workshop?

☆☆☆☆☆

**nustem**

Northumbria University  
NEWCASTLE



## Teachers and presenters feedback

This form was design to collect the feedback of teachers and presenters regarding the content and delivery experience of any of the MANAPRE educational resources.

**MANAPRE Teacher Feedback Survey**

Which of the following MANAPRE activities did you do with your class?

	Yes	No	Not sure	How many pupils did the activity?
1 Things in Air				
2 Monitoring air pollution				
3 Health impacts of air pollution				
4 Who studies air pollution - STEM Person of The Week				

What do you think children in your class have learnt as a result of taking part in this project?  
*Please write below*

What have you learnt as a result of taking part in this project?  
*Please write below*

Has taking part in this project made you think about or do anything differently?  
*Please write below*

**nustem**

## Lesson insert 4 - Who studies air quality ? STEM person the week

For this particular intervention we kindly ask presenters to use the pre and post evaluation tool linked to lesson 4. This is easy to implement as we ask students to use 6 words to describe people working in STEM, before and after the 5 week intervention.

What six words would you use to describe someone who works in STEM?

1.	4.
2.	5.
3.	6.

\* To be completed **before** the STEM Person of the Week activity takes place.