



# TeachEngineering

STEM Curriculum for K-12

**Study Design for Air Quality Research**



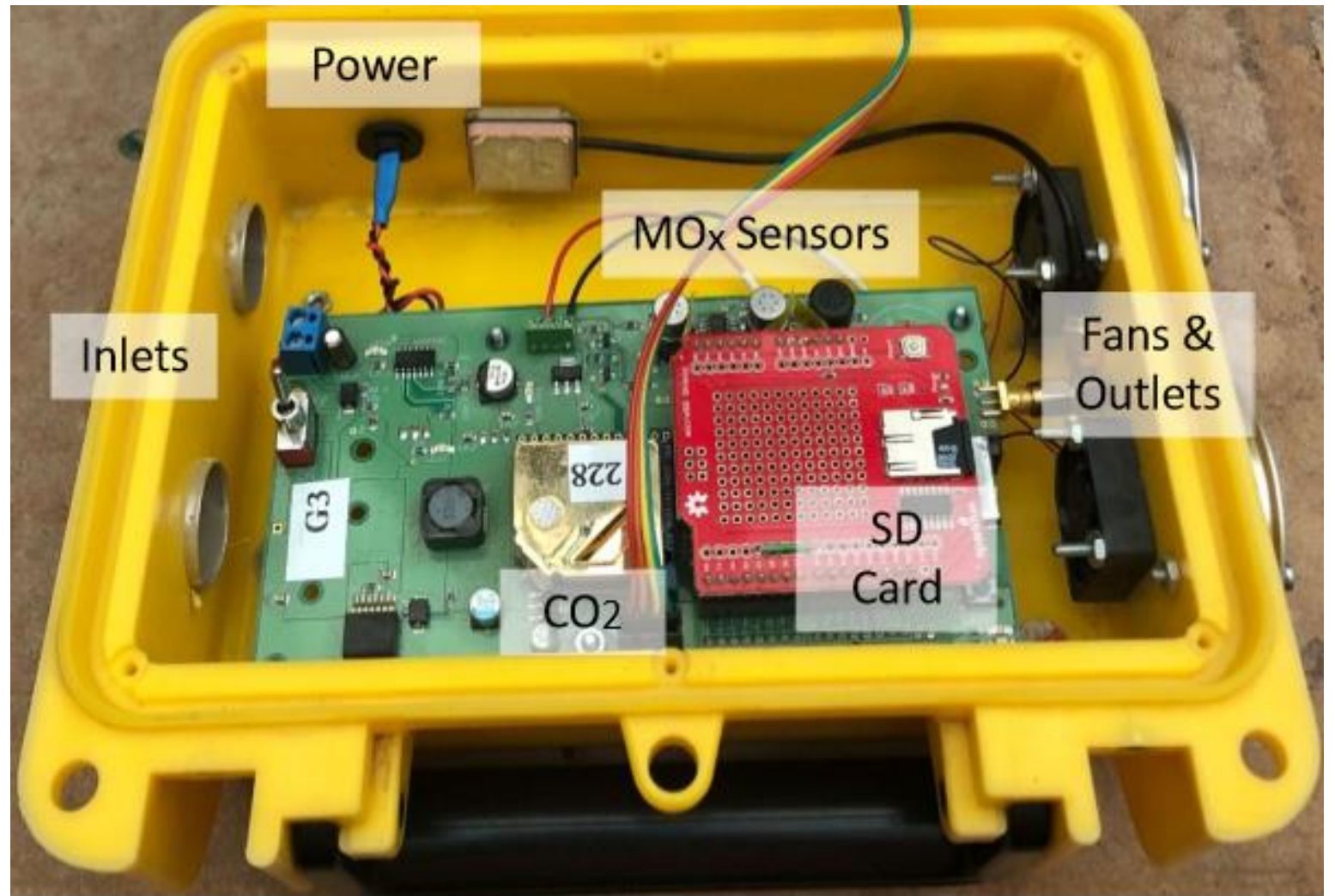
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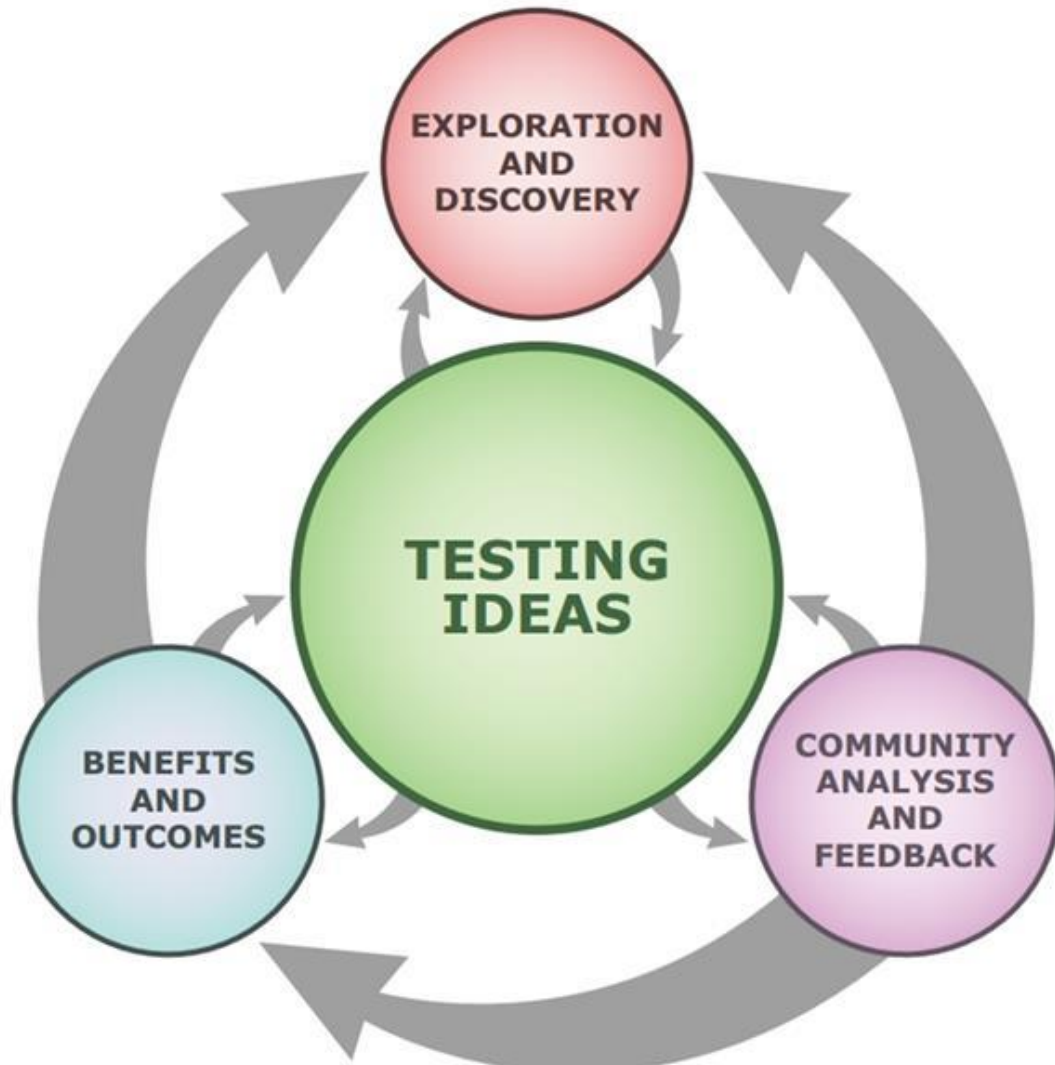


Reminder of  
what we  
have to work  
with...

Sensors inside a Pod  
air quality monitor →



# Overview and Recommendations for Starting Your Own Project



1. **Brainstorm** several ideas
  2. Discuss them with your group
  3. Select one and write a **hypothesis** or **research question**
- Remember it's okay if you do not know what will happen. So, either test a prediction using a hypothesis or conduct a more exploratory investigation using a research question.
1. Plan your project using the **template**

## *Example 1*

If you were to design an experiment right now in this classroom, using one air quality monitor and focusing on CO<sub>2</sub>, what could you do?

# Pollutants Review

- **Carbon dioxide (CO<sub>2</sub>)**

- Sources: biological respiration, combustion (complete)

- **Nitrogen dioxide (NO<sub>2</sub>)**

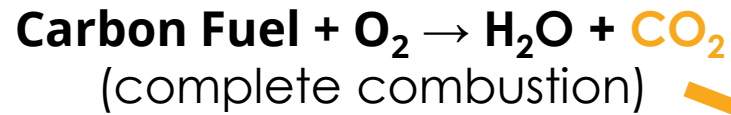
- Sources: combustion (high temperature)

- **Volatile organic compounds (VOCs)**

- Sources: combustion (incomplete), any organic compound capable of volatilizing at room temperature and pressures (such as cleaning products, paint, etc.)

- **Carbon Monoxide (CO)**

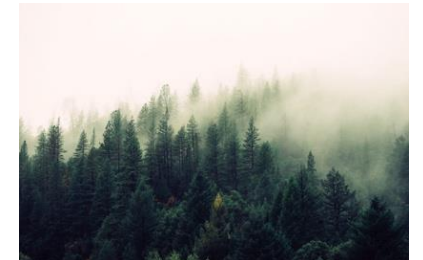
- Sources: combustion (incomplete), photochemical reactions in the atmosphere, producing chemicals



Incomplete or inefficient combustion  
→ **uncombusted VOCs**



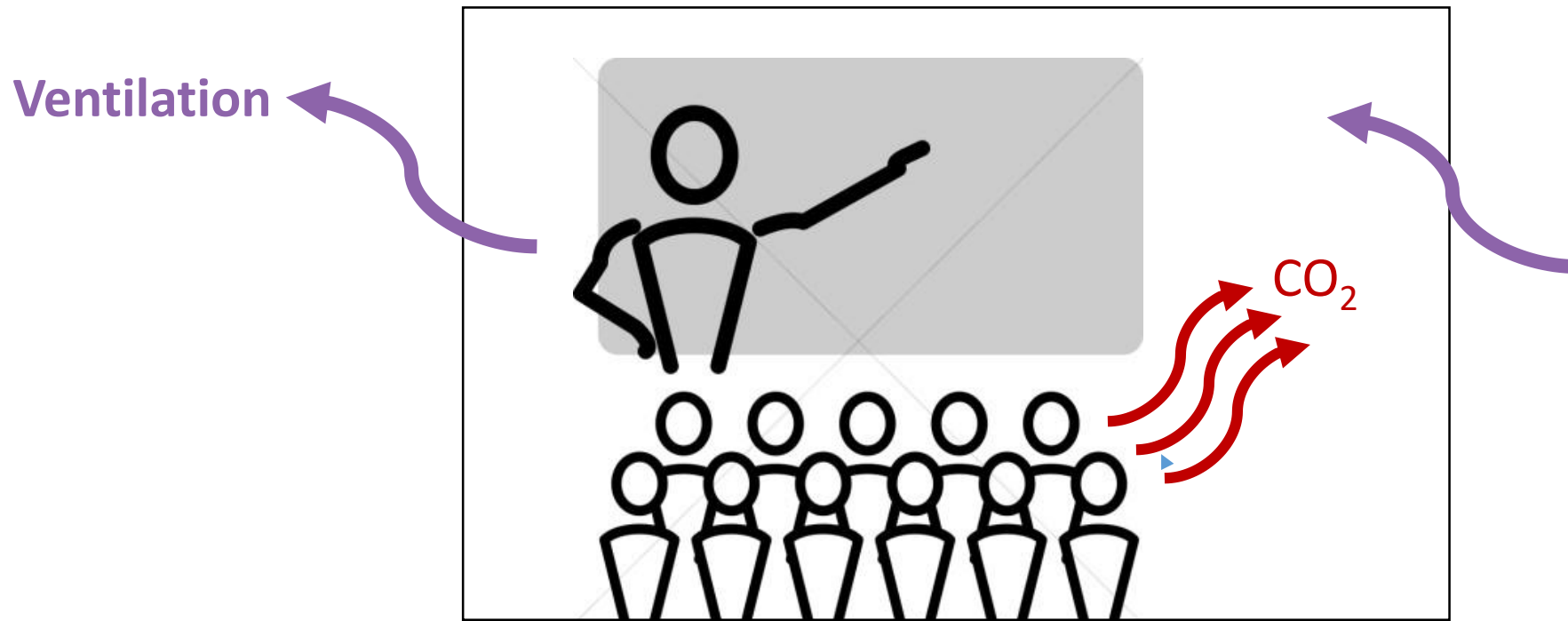
**other VOCs**



# You could...

Examine indoor air quality, for example:

- How effective is the ventilation?
- Or, vary the number of people in the room and calculate how fast CO<sub>2</sub> accumulates



## *Example 2*

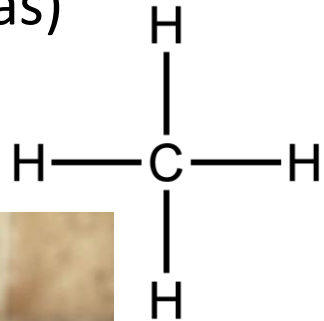
If you took two monitors home, what is an experiment you could do examining VOCs?

What about CO?

# VOC Sensors: Two different Sensors

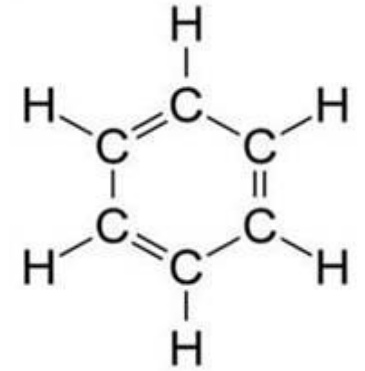
## Figaro 2600 (VOC 1):

Sensitive to lighter species (such as methane or natural gas)



## Figaro 2602 (VOC 2):

Sensitive to heavier species (such as benzene or gasoline vapors)





# You could...

- Compare the VOC emissions from different cleaning products in your home



vs.



## OR, for CO, you could...

- Compare CO concentrations in your living room versus your kitchen

## *Example 3*

What if you downloaded air quality data from Denver, CO, and from rural Colorado (such as the towns of Delta or Grand Junction)—**what questions could you ask?**

What if the data were from Beijing and Delta, CO?

# You could...

- Compare urban vs. rural ozone levels. These areas have different amounts of the  $\text{NO}_2$  and VOC “ingredients,” so you might see interesting differences

## Or, for Beijing, you could...

- Compare the levels of particulate matter in Beijing, where air quality is a major health crisis, to a rural area. For example, how does the worst air quality day of the year in Delta, CO, compare to an average day in Beijing?



VS.



# *What bigger themes does your air quality project relate to?*

- **Public Health:** projects/questions that examine pollutants that have an impact human health
- **Climate Change:** projects/questions that examine greenhouse gas pollutants
- **Energy Systems:** projects/questions that compare different fuels or provide insight into how we obtain and use energy
- **Building Systems:** projects/questions that examine indoor air quality from an engineering standpoint (such as ventilation efficiency)
- **Meteorology:** projects/questions that examine the impact of meteorology on air quality (such as air quality during a winter temperature inversion vs. no inversion)

*\*Your project/question may also relate to more than one of these and this is not a complete list*

# Final Notes...

- Come up with **ideas that interest you** → then, your teacher or mentor can help you turn it into a project
- Check your data frequently! (The monitors are not perfect)
- Leave time to collect a second data set, if necessary
- Use the Pods for shorter experiments (less than a few days); if you want long-term data (weeks or months), use existing sources