



TeachEngineering

STEM Curriculum for K-12

Study Design for Air Quality Research



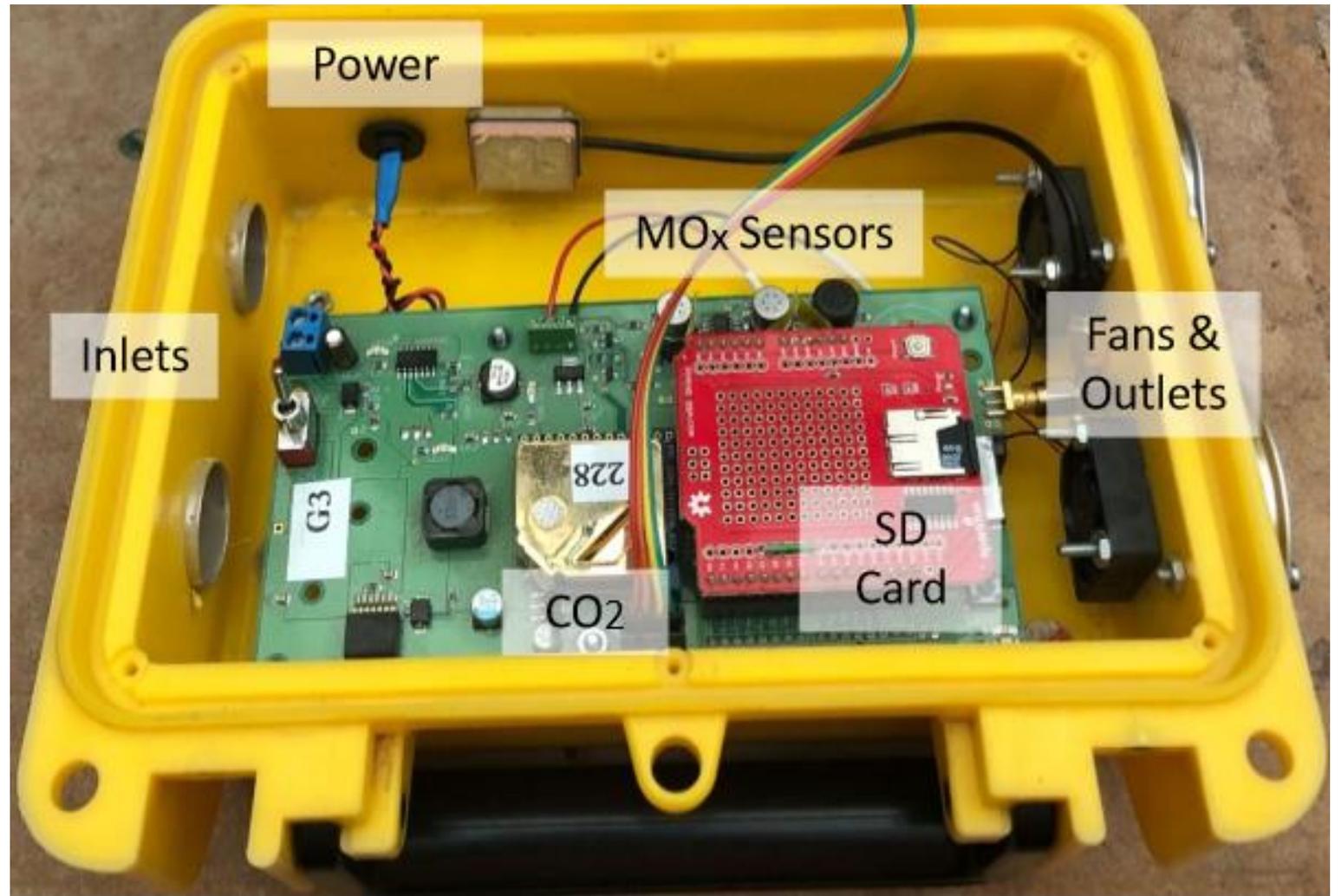
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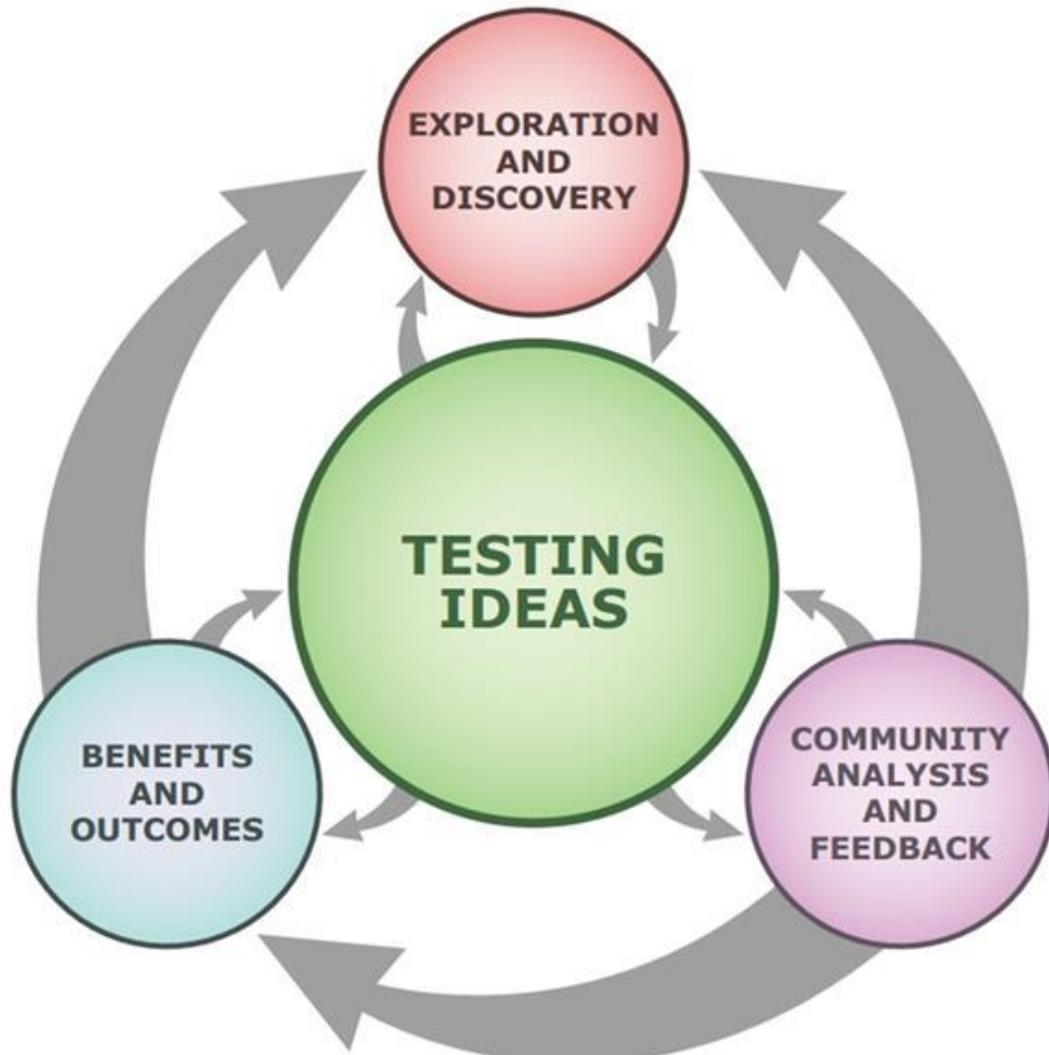


Reminder of
what we
have to work
with...

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 CO₂, what could you do?

Pollutants Review

- **Carbon dioxide (CO₂)**

- Sources: biological respiration, combustion (complete)

- **Nitrogen dioxide (NO₂)**

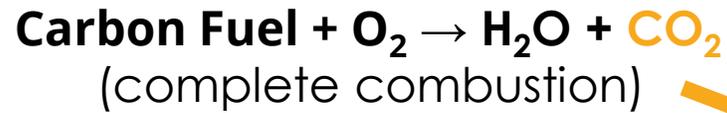
- Sources: combustion (high temperature)

- **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**



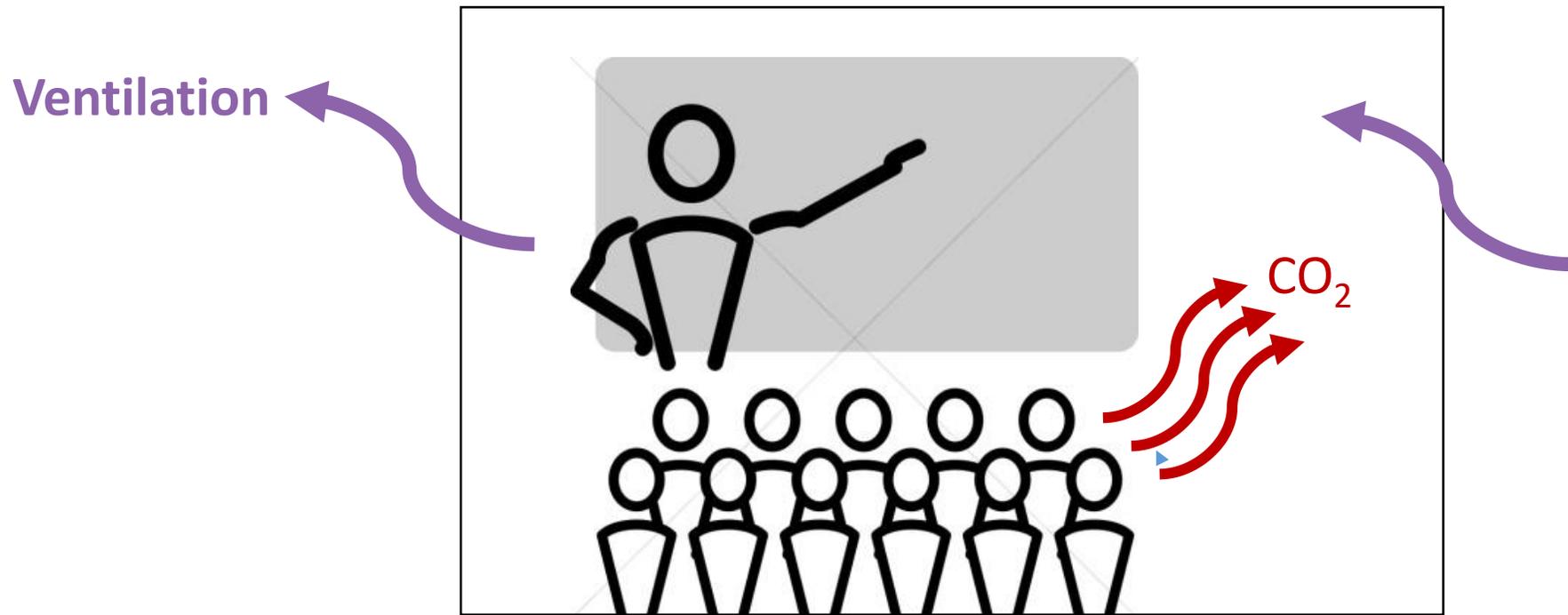
other VOCs



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 CO₂ accumulates



Example 2

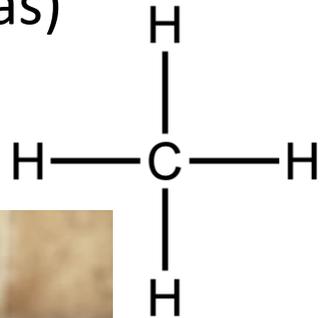
If you took two monitors home, what is an experiment you could do examining VOCs?

What about CO?

VOC Sensors: Two different Sensors

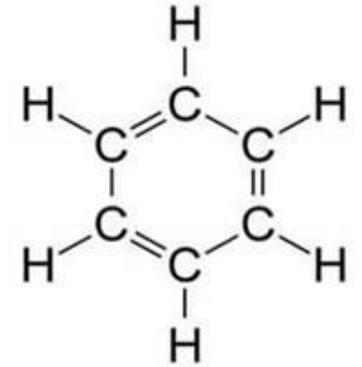
Figaro 2600 (VOC 1):

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 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