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Indoor Air Quality

Background

The air that we breathe provides us with fresh oxygen needed to fuel our cells and keep us healthy. However, when we breathe in air that might be carrying pollutants, dangerous fumes, mold spores, or other harmful elements we can be harming our bodies!

Indoor Air Quality (IAQ) is all about making certain that our lungs are receiving fresh, clean air through appropriate building ventilation and also monitoring things that could be harmful.

Using databot™ sensors, you will be able to evaluate four important IAQ indicators - **temperature**, **humidity**, **volatile organic compounds (VOCs)** and **CO2** levels. Your mission will be to look for health hazards in your classroom, home, school building, etc.

The Mission

You are a data scientist charged with evaluating the indoor air quality in your building to make sure it is safe, comfortable, and optimized for the health and mental performance of everyone in the building. Knowing there are four important indicators for indoor air quality, you will brainstorm a survey of the room or building taking into account issues such as time of day, day of the week, type of environment, anticipated amount of people in areas, etc. Once you have determined your approach to evaluating IAQ you will:

- Formulate your statistical investigative question(s).
- Plan your process and collect the required data.
- Analyze this data.
- Clearly communicate the results of your study.

Important Terms

CO2: A colorless, odorless gas naturally present in the air you breathe and is absorbed by plants in photosynthesis. Excessive levels of **CO2** are unhealthy and are managed in buildings by proper **HVAC** systems.
Humidity: The amount of moisture in the air. High levels of humidity indoors can contribute to microbial activity which can affect indoor air quality.

Grades: 6 & Up
Time: 45 Minutes (longer if desired)
Subject: Environment & Data Science
Topics: Indoor Air Quality, VOCs, Humidity, Temperature, CO2

What You Will Need/Prep

- databot™ & a smart device (iOS or Android).
- Install Vizeey™ & read the Fast Start Guide.
- Do the Sensor Starters for Temperature, CO2, VOCs and Humidity.
- Scan the QR code for **Indoor Air Quality.**

Data Science Practices

Good science requires proper procedures to effectively study phenomena in the world around you. When collecting data to help answer questions, follow good data science practices and you will master a valuable skill for life.

Formulate statistical investigative questions. Clearly state your mission.

Collect/consider the data. Plan your data type(s) and collection process.

Analyze. What does it all mean? Look for patterns. Study the data.

Interpret and communicate. Clearly explain the story the data is telling.

Attribution: Increase your knowledge. Read more about these Big Ideas in Data Science drawn from the NCTM GAISE II at youcubed.org.

HVAC: Heating, Ventilation, and Air Conditioning (**HVAC**) is the system in your building that keeps your air fresh and temperature controlled. Poor **HVAC** engineering can result in too much moisture in the air, excessive **CO2** or heat, or other unhealthy elements.
Temperature: A measure of a physical property of a substance – how hot or cold is it? Warmer indoor temperatures can affect important air quality issues such as the transmission of the Corona Virus - transmission goes down as the temperature goes up!
VOCs: Chemicals that evaporate at room temperature and are emitted by substances like cleaners, paint thinner, and paints. Levels that are too high, or even prolonged exposure to low levels, can be harmful to your body and cause health problems.

Statistical Investigative Question

Use the IAQ data points to formulate your Statistical Investigative Question. You can base it around using sensors for measuring one, two, three, or all four indicators.

- temperature
- humidity
- volatile organic compounds (VOCs)
- CO2 levels

The data you collect should answer your question! Be very specific as you formulate your investigation. A few examples might be:

- *"Do some areas in the building have better IAQ than others?"*
- *"Are CO2 levels higher in the afternoon?"*
- "Are areas on the 2nd or 3rd floor more humid than the 1st?"

IAQ Data Points

CO2:

400 PPM and below: Normal concentration in outdoor air.
400 - 1,000 PPM: Typical of occupied indoor air with good **HVAC**.
1,000 - 2,000 PPM: Drowsiness, stuffy, complaints of poor air.
2,000 - 5,0000 PPM: Headaches, sleepiness, poor concentration
5,0000 PPM: Workplace exposure limit in most places - DANGER!
> 40,000 PPM: Brain damage, coma, and death.

Temperature:

Temperatures above 68° F reduces virus transmission rates.

Humidity:

Indoors, **relative humidity** between 40%-60% is optimal.

VOCs:

0 - 250 PPB – **VOC** contents in the air are low.
250 - 2000 PPB – Try and identify the source and reduce levels.
> 2,000 PPB– Danger! Immediately ventilate and find the cause.

Data Collection/Process Plan

Plan the data you need to collect to answer your Statistical Investigative Question. You may want to create a table like the one shown here or use another method to get organized.

Think about your process.

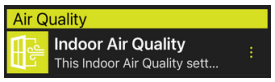
- Are you gathering data from more than one location?
- Will you be gathering data at different times and days?

Use your Investigative Question to guide your plan. Ready to begin? Let's use Vizeey™ and databot™ to collect your data.

Location	Time	Notes and Plan
Classroom	1:00	Test live data; Rec. 1 Min.
Gymnasium	1:10	Test live data; Rec. 1 Min.
Office	1:20	Test live data; Rec. 1 Min.
B. Restroom	1:30	Test live data; Rec. 1 Min.
G. Restroom	1:40	Test live data; Rec. 1 Min.

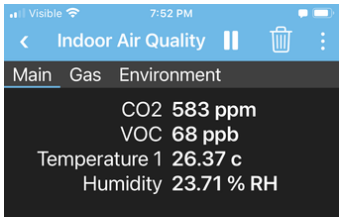
An example of a collection plan.

1. Click on the IAQ Experiment in Vizeey™ & connect to your databot™.



2. Use ▶ ❚❚ to start and pause the experiment.

3. Explore the three data views of your indicators to see the data in numeric or graphical displays.



4. Practice collecting and visualizing the data, then erase your test data and capture your official data sample for analysis!

Analyze/Study Data

There are many ways to analyze the data. Use the Vizeey™ tools to identify highs, lows, and trend lines or export the data for analysis in spreadsheets such as Excel or Sheets.

The tables to the right provide an example of an analysis of one dataset. Using spreadsheet formula functions a tidy presentation of the data collected is organized to present.

How will you analyze your data? How can you best process the data to answer your Statistical Investigative Question?

Time (S)	CO2	VOC	Humidity	Temp 1
0.42	408	33	25.72	26.25
0.56	400	88	25.88	26.25
0.71	400	52	25.69	26.25
0.81	407	74	25.68	26.25
0.95	400	44	25.71	26.25

Raw Exported Data

Average Values		Notes
CO2	517.42	Safe levels.
VOC	100.42	Safe levels.
Humidity	24.41	Low humidity.
Temperature F°	79.41	High temperature for comfort.

Processed Data

Interpret/Communicate

Use the data you collected to answer your Statistical Investigative Question. How will you present this information - will you use a data table, a pie chart, a bar chart? What is the best way to present this information to your audience?

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Formulate your Statistical Investigative Question and clarify your mission using up to four indicators based on sensor data collected by databot™:

- Temperature
- Humidity
- Volatile Organic Compounds (VOCs)
- CO2

Name:
Lab Partners:
Date:
Class/Period:

Indoor Air Quality Indicators

VOCs:
0 - 250 PPB – **VOC** contents in the air are low.
250 - 2000 PPB – Try and identify the source and reduce levels.
> 2,000 PPB– Danger! Immediately ventilate and find the cause.

CO2:

400 PPM and below: Normal concentration in outdoor air.
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Temperature is an instant indicator of indoor air quality, being too hot or cold affects your comfort and ability to work and concentrate. For temperatures between 19°C to 24°C (66°F to 75°F) prevent nasal passages from drying which reduces susceptibility to viruses. Finally, virus transmission (such as Covid-19) becomes less and less affective above 20° C (68° F). Covid transmission is almost blocked or highly ineffective at temperatures above 30° C (86° F).

Humidity:

Indoors, **relative humidity** between 40%-60% is optimal for IAQ. Above 60% becomes too moist and can contribute to the growth of mold and other allergens. Below 30% can dry out your skin and sinus and promote static electricity.

Statistical Investigative Question

Formulate your question using the IAQ indicators. A good question will have a purpose. For example will your investigation possibly make the world a better place - safer, cleaner, etc.? Second, your question needs to be answerable using the data you are collecting so be very thoughtful about how the sensor data you collect can answer your question.

Example Question

"Are VOC levels higher near janitorial supplies than elsewhere in the building. If so, are they at a dangerous level that needs to be mitigated?"

A good question will be specific and can be answered with your data. This example has a very clear YES or NO answer to the first half. The levels will either be higher or not. The second half of this question will also be clearly answered by the data. If VOC levels are higher than 250 they may be dangerous and a solution needs to be identified to make the area safe.

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Data Collection/Process Plan

Collection: Write your plan for collecting the data to answer your Question. Be specific on how, where, and when you will gather your data and the sensors used.

Processing: Does your data need to be cleaned or filtered? Describe how you plan to evaluate your data. Will you be exporting it for analysis in other software or using Vizeey™?

Analysis

Write your plan for analyzing and visualizing your data. Will you put it into a data table? A bar graph? What makes sense. Consider, is your data clean and dependable? Are some values "anomalous" and wildly different than others? Do you need to filter the data somehow? How controlled was your data collection, is is possible some of the data may have been compromised? Do you need to apply mathematical functions to your data to better understand it? There are many layers to analysis so go deep and really dig!

Interpret and Communicate

Write your plan for communicating the results of your study. What aids will you use? What is the message you want to convey to your audience? Will you present with passion and logic or humor and persuasiveness?

Write down the story you want to tell with your data and how you want your audience to react.

For a detailed description, by grade, of each stage visit: https://www.youcubed.org/data-big-ideas/

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