Corsi-Rosenthal Box Learning Module: How Can We Make Clean Air Accessible for Schools? (Resource Exchange)

Aaron Richardson, University of Connecticut

Aaron Richardson studies and teaches with a focus on social and racial justice, accessibility, and creating relevant curriculum that will make use of students' lived experiences and knowledge to help them bring their own personal meaning to their education and into the classroom. Aaron Richardson's interest in the Corsi-Rosenthal Learning Module project revolved around accessible, relevant science and engineering education for students by using phenomena that can directly impact students' lives and communities to inform the direction of the unit plan. It is his hope that these and the future curricula he will work on will help to include and empower more diverse students to see themselves in the fields of science and engineering, as well as see themselves as advocates for change and innovation in their communities.

Aaron Richardson is a trained horticulturist with fifteen years of experience in the field dating back to his time in the National FFA Youth Organization, and has gone on to acquire Bachelor's degrees in Horticulture, Ecology & Evolutionary Biology, and Biology Education from the University of Connecticut (UConn). Aaron is currently a Master's student with the Neag School of Education at UConn, seeking a Master's of Curriculum and Instruction, and will be entering the public teaching workforce after graduation of Spring 2024.

Todd Campbell, University of Connecticut

Todd Campbell is a Professor and Head of the Department of Curriculum and Instruction at the University of Connecticut.

Marina A. Creed, UConn Health and UConn School of Medicine

Marina Creed is an Instructor in the Department of Neurology at the University of Connecticut School of Medicine and practicing Neuroimmunology Nurse Practitioner in the Multiple Sclerosis Center at UConn Health. She has been engaged in translational public health efforts throughout the COVID19 pandemic to improve outcomes for her immunosuppressed patients by reducing exposure to infectious and non-infectious air pollution in public schools and community spaces throughout the State of Connecticut. She founded and is the director of the UConn Indoor Air Quality Initiative, a cross-campus, multidisciplinary team of scientists and clinicians studying low-cost air purifiers in both laboratory and real-world settings.

Dr. Kristina M. Wagstrom, University of Connecticut

Dr. Kristina Wagstrom is an associate professor in Chemical and Biomolecular Engineering at the University of Connecticut in Storrs, CT. She specializes in applying chemical engineering principles to better understand the human and ecosystem health impacts of air pollution (outdoors and indoors).

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How can we make clean air accessible for schools?

OUR LESSON PLANS

- **8th Grade**, up to 3 days
  Physical Sciences
  Life Sciences - Biology
- **5th Grade**, up to 4 days
  Engineering
  Earth and Life Sciences
- **Girl Scouts**, 1.25 hours
  Engineering
  Physical Sciences

FIND DETAILED PLANS

The detailed lesson plans are freely available online. The air cleaners cost ~$60/ea to build.

NEXT GENERATION SCIENCE STANDARDS

Covers topics in engineering and earth and life sciences aligned to the NGSS.

HANDS ON

Students get the opportunity to build a working air cleaner that they can use in their classroom or donate to somewhere in the community.

SOCIAL JUSTICE

Provides a framework for discussions around environmental justice aligned to Learning for Justice's Social Justice Standards.

CONTACT US

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8TH GRADE

This 8th grade lesson plan includes 3 days of activities with the ability to only use one day's worth of activities. The lesson plan includes hands on components alongside freely available multimedia resources. Students will explore topics related to the ideas of structure and function of biological systems, relationships in ecosystems, engineering problems, and environmental justice.

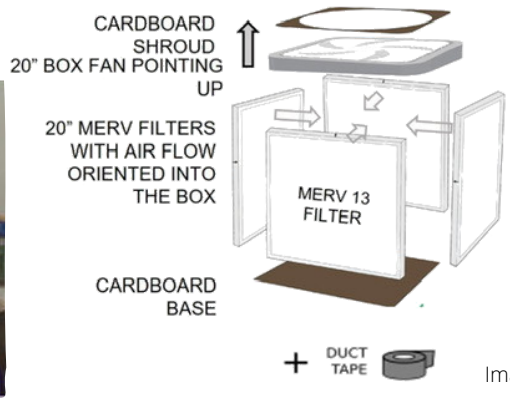
5TH GRADE

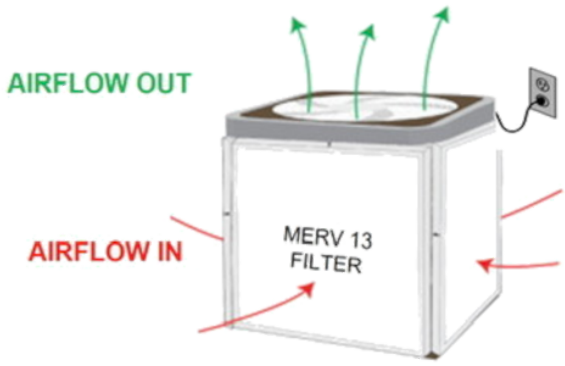
This 5th grade lesson plan includes 3-4 days of activities with the ability to only use one day's worth of activities. The lesson plan includes hands on components alongside freely available multimedia resources. Students will explore topics related the ideas of biodiversity and human, natural resources, human impacts on earth systems, structure and properties of matter, engineering problems, and environmental justice.

GIRL SCOUTS

This is an activity designed for a single troop meeting and should take a little over an hour. It focuses on the themes of air quality and human health. While written for a Brownie (2nd and 3rd grade) troop, small adjustments would make it appropriate for any level of Girl Scouts or Scouts BSA. Allowing additional time for the scouts to decorate the filter makes this a great informal STEAM activity. It also teaches social responsibility as the Scouts find a place to donate the built boxes.

$60 TO IMPACT





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NEAG SCHOOL OF EDUCATION

Grade 5 Unit Plan

Authors: Aaron Richardson, Jannatul Anika, Todd Campbell
Unit Title: Corsi-Rosenthal Box Learning Modules
Science Area Focus: Engineering, Earth and Life Sciences

Note: These instructional materials were co-developed by two graduate students and a professor/researcher in science education and in the Neag School of Education

Grade 5 Unit Plan

Unit Author(s):	Aaron Richardson, Jannatul Anika, Todd Campbell
Unit Title:	Corsi-Rosenthal Air Filtration Box
Science Area Focus:	Engineering, Earth and Life Sciences

STAGE 1: PLANNING FOR ENGAGEMENT WITH IMPORTANT SCIENCE IDEAS

PART A: Unpack the Standards. *This is completed by reviewing the Framework for K-12 Science Education to identify the Disciplinary Core Ideas (DCI), DCI Progressions, and Performance Expectations that will make up the student learning targets of the unit.*

STEP 1. Based on the science area focus above, identify the appropriate **disciplinary core idea(s)** (DCI) [include both DCI (e.g., MS-LS2) and applicable **sub-DCIs** (e.g., MS-LS2A)]

3-5-LS4.D: Biodiversity and Humans: Populations live in a variety of habitats, and change in those habitats affects the organisms living there.
3-5-ESS3.A: Natural Resources: Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.
3-5-PS1.A: Structure and Properties of Matter: Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model shows that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects.

STEP 2. Identify the relevant **performance expectations** that you are working toward.

3-LS4-4–Populations live in a variety of habitats, and change in those habitats affects the organisms living there
5-ESS3-1–Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
3-5 ETS1-1–Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

PART B: Identify a Scientifically Rich, Complex Anchoring Phenomenon. *The anchoring phenomenon will serve as the real-world event that students work to explain as the purpose for engaging in the unit.*

STEP 1. Describe a **scientifically rich, complex environmental phenomena** that will require students to use multiple science ideas that are central to the DCI(s) to explain.

Residents of the Waterfront South neighborhood of Camden, NJ have never been able to safely open their windows; the air is too filled with pollutants and debris, sometimes making it hard to breathe or be outside for extended lengths of time. Despite neighboring tourist areas and business centers in the

surrounding cities such as Philadelphia, Waterfront South residents have the highest risk for asthma, COPD (Chronic Obstructive Pulmonary Disease), and certain cancers due to the pollution in the air. The neighborhood is also home to an illegal dumpsite, owned by developers and construction companies. Most of the residents (94% of them) of Waterfront South are nonwhite and low income. As a result of trash-to-steam plants and other polluting bodies, the residents of Waterfront South were also at increased risk for Covid-19 than the rest of Camden.

News Report (video): https://6abc.com/environment-inequity-race-racial-disparities/11152688/

STEP 2. List **resources** (websites, articles, books, etc.) that help you (i.e., the teacher) better understand the anchoring phenomenon:

1. AIR QUALITY/C-R BOX RESOURCES:

a. **Corsi's video for UC Davis on how to construct a C-R Box:** Corsi DIY Video

b. **Article on the efficacy of the Corsi-Rosenthal box:** https://www.tandfonline.com/doi/full/10.1080/02786826.2022.2054674

c. **Activities found on the topic of air quality (from this unit https://learn.concord.org/resources/626/will-the-air-be-clean-enough-to-breathe) :** https://activity-player.concord.org/?runKey=ad1fe27d-d6b8-4a08-b092-26d985ba1b75&sequence=https%3A%2F%2Fauthoring.concord.org%2Fapi%2Fv1%2Fsequences%2F389.json&sequenceActivity=0

d. **Human health:** https://www.youtube.com/watch?v=d9Ojbx3WgBM

2. AIR POLLUTION RESOURCES:

a. **Air Pollution for Kids**: https://www.youtube.com/watch?v=Yjtgu2CxtEk

b. **Task 1 Introduction Video**: https://www.youtube.com/watch?v=e6rglsLy1Ys

c. **Hazardous Air Pollutants**: https://www.epa.gov/air-quality-management-process/managing-air-quality-air-pollutant-types

Urban Air Toxic Pollutants: https://www.epa.gov/urban-air-toxics/about-urban-air-toxics

3. AIR FILTERING RESOURCES:

a. MERV Rating: https://www.youtube.com/watch?v=lT7oi-Yx0fg

b. Filters: https://www.youtube.com/watch?v=WhiTlkZlwl4

4. JUSTICE-CENTERED RESOURCES:

a. **Waterfront South's differing air quality from surrounding towns (Phenomenon):** https://6abc.com/environment-inequity-race-racial-disparities/11152688/

b. **Health disparities:** https://www.lung.org/clean-air/outdoors/who-is-at-risk/disparities

c. **Effects of Covid-19 based on race:** https://www.mayoclinic.org/diseases-conditions/coronavirus/expert-answers/coronavirus-infection-by-race/faq-20488802

d. **"Black communities are sacrifice-zones":** https://diversegreen.org/air-pollution-black-communities-are-sacrifice-zones-shaila-vester-skinner/#:~:text=There%20is%20a%20high%20volume,poses%20an%20even%20greater%20threat.

e. **Exclusionary zoning practices (and embedded links)**: https://www.whitehouse.gov/cea/written-materials/2021/06/17/exclusionary-zoning-its-effect-on-racial-discrimination-in-the-housing-market/
   i. https://tcf.org/content/facts/understanding-exclusionary-zoning-impact-concentrated-poverty/?agreed=1
   ii. https://law.stanford.edu/wp-content/uploads/2018/03/mangin_25_stan._l._poly_rev_91.pdf

https://tcf.org/content/facts/understanding-exclusionary-zoning-impact-concentrated-poverty/?agreed=1

STEP 3. Identify **technologies** (CS, AI, machine learning, etc.) related to the phenomenon and describe how the technologies listed above are used in solving the environmental problem:

1. **EDUCATION TECHNOLOGIES:**

   a. **Videos:** Task 1 Introduction Video: https://www.youtube.com/watch?v=e6rglsLy1Ys

2. **MATERIAL TECHNOLOGIES:**

   a. **For C-R Box:**
   - 20-in. portable box fan–**Corsi recommends keeping the cardboard from packaging; this will be used to block holes that can cause air leaks**
   - 4 MERV 13 2-in. air filters
   - Duct tape
   - Scissors

   b. **For models:**
   - Large paper pad
   - Markers
   - Pencils/pens
   - Sticky notes
   - Tape

STEP 4. Develop a **driving question** to frame the anchoring phenomenon for the students. State your driving question below.

How do we make clean air accessible?

PART C: Provide a Target Written Explanation. *The target written explanation serves as a resource for identifying which science ideas are important for explaining the phenomenon.*

After identifying the important science ideas, you can consider when and how these ideas are introduced and explored across the unit.

Provide a **target written explanation** of the phenomenon. This should be written at the appropriate grade level. (Note: the explanation should identify how science ideas are coordinated to explain the occurrence or event that happened in the world).

Residents of the Waterfront South neighborhood of Camden, NJ cannot open their windows because the air is filled with pollutants, making it hard or even dangerous to breathe or be outside for long periods of time. The air is polluted because factories–such as cement plants, sewage treatment, and trash incineration plants–that are creating pollution are located in this neighborhood. Because industry is centered in this area, neighboring tourist areas and business centers in the surrounding cities are kept relatively pollution free. Waterfront South residents have the highest risk for asthma, COPD (Chronic Obstructive Pulmonary Disease), and certain cancers due to the pollution in the air. 94% of Waterfront South residents are also nonwhite. This higher rate of respiratory problems also resulted in higher rates of Covid-19 in this neighborhood compared to surrounding areas.

Air pollution is caused by gases and particulates that have been created from human activity, such as burning fossil fuels and garbage, by driving cars, or by industrial plants and manufacturers. Many of these particulates and gases can have short and long term health effects on humans when breathed in, including respiratory infections, heart disease, lung cancers, and increased exposure to–and more serious health problems and hospitalizations from–Covid-19. Health problems for people living in highly polluted areas are amplified as these residents tend to be low income and have poor access to healthcare. In many of these cases, these high pollution zones have a high percentage of non-white residents compared to surrounding areas with cleaner air.

The reason for these discrepancies in location of industrial plants is due to the legacy of people in power, often white leaders, creating exclusionary zoning policies that limited places where people of color were allowed to live or, after exclusionary race-based zoning was made illegal, creating policies or laws that allowed companies to avoid regulations meant to protect against race-based zoning (see Resource 4.e.). Additionally, because of the creation of restrictive land use and building codes, many types of neighborhoods and industries were kept out of what would become high value areas, while also relegating most low income people to high poverty areas.

In order for these differences in air quality to be fixed, there need to be steps taken to protect communities of color from being overly burdened by where laws dictating where industrial zones can be built, while exclusionary zoning practices need to be interrogated to further consider how they perpetuate inequality related to where wealth and resources are concentrated. Additionally, access to cleaner energy is needed, and healthcare access needs to be addressed.

PART D: Identify Science Ideas. *(REVISIT AND FINALIZE PART A: UNPACK THE STANDARDS).*

Using the target explanation above, identify the science ideas that are essential for explaining the phenomenon. After identifying the science ideas, identify at least one science task for each science idea as a resource that can be used during Stage #3.

STEP 1. **Identify the science ideas** within the explanation that are central to students explaining the phenomenon.

Science Idea 1: Air Pollution & Air Quality
Science Idea 2: Air Filtration
Science Idea 3: Human Health

STEP 2. For each science idea identified above, **choose one task, reading, video, simulation, or investigation that will help students understand this important idea**

and begin to see its usefulness in explaining the anchoring phenomenon. Do this for each science idea below.

Science Idea 1–Air Pollution & Air Quality: Investigation into what air pollutants are, and video explaining phenomenon.
Science Idea 2–Air Filtration: Construction of a Corsi-Rosenthal box and accompanying questions about how its construction and design related to air pollution.
Science Idea 3–Human Health: Justice 12 graph and discussion of air pollution impact on health.

***(If Applicable)* PART E: Identify Social Justice and Equity Ideas**. *Identify the social justice ideas that are either central to supporting student engagement and connection to science (i.e., identity, diversity) you want to focus on during the unit or essential for explaining and taking action to resolve social injustices related to the phenomenon. After identifying the social justice ideas, identify at least one instructional strategy or task that will help you realize each social justice idea as a resource that can be used during Stage #3.*

STEP 1. Identify the social justice ideas that are central to supporting student engagement and connection to science (i.e., identity, diversity) or essential for explaining and/or taking action to resolving social injustices related to the phenomenon.

Justice 12–JU.3-5.12: I know when people are treated unfairly, and I can give examples of prejudice words, pictures and rules.
Justice 14–JU.3-5.14: I know that life is easier for some people and harder for others based on who they are and where they were born.

STEP 2. For each social justice idea identified above, **choose one instructional strategy, task, reading, video, simulation, or investigation that will help students understand this important idea and begin to see its importance in supporting their connection with science (i.e., identity, diversity) or for explaining and taking action to resolve social injustices related to the phenomenon.** Do this for each social justice idea below.

Justice 12–JU.3-5.12: Picture of graph from 2019 EPA Toxics Assessment of Philadelphia-Camden-Wilmington Area
- Questions about inequity will accompany this activity

Justice 14–JU.3-5.14: ABC News Video of Phenomenon: https://6abc.com/environment-inequity-race-racial-disparities/11152688/

STAGE 2: NEGOTIATING IDEAS AND EVIDENCE THROUGH TASKS

The goal of the second stage is to support on-going changes in students' thinking by providing learning experiences that help coordinate their own ideas with powerful ideas in science to build a scientific explanation of the anchoring phenomenon. This involves designing or adapting a number of purposeful tasks, coordinated with the important science ideas identified earlier, and the construction and use of public records such as a Summary Table to help keep track of ideas over time. Important in this stage is the revision and testing of the

students' models. This stage makes up the majority of the unit as the class works to develop their explanations of the phenomenon through engagement in the practices of science.

PART A: Develop Unit Task Outline. *Provide the outline of each purposeful task that includes the introduction or highlighting of science ideas to reason with, the task launch, the procedures for the main task, and how the summary table will be updated. Each task may take one or more days. For each task, identify target Disciplinary Core Ideas (DCIs), Science and Engineering Practices (SEPs), and Crosscutting Concepts (CCCs) that will guide student sensemaking in that task. Also include an outside of how you will facilitate the mid-unit model revision.*

Purposeful Task	Outline*

Task #**1**:
Introduction to Air Pollution and Air Quality
Day **1**
 	
DCI:
3-5-LS4.D: Biodiversity and Humans
3-5-ESS3.A: Natural Resources
SEP:
- Asking Questions and Defining Problems
CCC:
Cause and Effect
	Agenda:
	Introductory questions:
	- *When you think of air pollution, what comes to mind? (This could be a source, a process, or an effect)*
	  - If students struggle to respond, use eliciting questions such as:
	  - *Can you think of a time in your life when you noticed air felt or smelled or even tasted different?*
	  - *Has anything ever made it hard or unpleasant for you or someone you know to breathe?*
	  - *How does clean air feel to you?*
	- *How have you heard air pollution talked about by the people in your life or in the media?*
	- *Why do you think that people talk so much about the air and air pollution?*
	
	Air pollution:
	- Students will create an initial hypothesis answering the driving question: **How do we make clean air accessible?**
	-
	- Questions to help their thinking:
	  - *How do you think we clean the air?*
	  - *Has anyone ever seen something that is used to clean the air?*
	  - *How would you clean the air? What would you do or use?*
	Backpocket questions:
	- On accessibility**:**
	  - *What do we mean when we say accessibility?*
	  - *Has anyone heard the word accessibility before?*
	  - *What does accessibility mean to you?*
	- *How does accessibility apply to air quality?*
	
	Main task (include backpocket questions):
	Class discussion:
	- **Justice 14**: Watch Camden Air Pollution news report: https://6abc.com/environment-inequity-race-racial-disparities/11152688/
	
	Video: https://www.youtube.com/watch?v=e6rglsLy1Ys

	- *What is air pollution?* - *What are the causes of air pollution?* - *How does air pollution affect the environment?* - *What is the effect that air pollution has on human health?* Accompanying organizer to give students a key for finding information and making sense of the purpose of the C-R box Backpocket questions: - *What does it mean for air to be polluted?* - *How does air become polluted?* - *Can you think of something that explains why tiny particles in the air have such a large impact?* Looking ahead: - Students can be informed that the following class will be a workshop in building an air filtering device where they will learn how they can apply what was discussed this first day Adding to the summary table (see example Summary Table below in Part B): - Direct students to appropriate column and activity. - Students will come to consensus on how the task demonstrates the phenomenon. - Students will come to consensus on why this task is important for understanding the phenomenon.

Task #**2**:
Introducing the Corsi-Rosenthal Box (C-R Box)
Day **2**
 	
DCI:
3-5-ESS3.C: Human Impacts on Earth Systems
3-5-PS1.A: Structure and Properties of Matter
 	
SEP:
- Constructing Explanations and Designing Solutions
 	
CCC:
Systems and System Models
Structure and Function
	Agenda:
	- Air pollution discussion
	- Assembling the C-R Box
	- Discuss how students think this device works to clean the air
	- Creating a model
	
	Main task (include backpocket questions):
	Discussion and warmup of how students think air pollution can be lessened/fixed/solved:
	- Should bring students to the engineering of how to take pollutants out of the air
	- Questions to aid their thinking and to get them to the idea of masks:
	  - *Can you remember some of the things we are told to do with Covid-19?*
	  - *What is something people say to do when you are feeling sick?*
	
	- Once students have grasped the idea of masks:
	  - *Why do you think we wear masks?*
	  - *How do masks affect the air we breathe in?*
	  *This should bring students to the idea of masks as filtering devices. Students should understand that a mask is a type of barrier, and barriers are capable of blocking certain particles of air from getting through
	
	C-R Box assembly according to video: Corsi DIY Video

	Questions to aid student comprehension and deep sense-making:
	- While assembling the filter pads in a specific direction to make sure air particles are trapped on inside of box:
	  - *Why do you think it is important for the filters to face inwards before we attach the fan?*
	  - *What do you think would happen if the filters were facing the other way?*
	- While taping the pads together and checking for any gaps:
	  - *Why do we need to make sure that the corners of these filters are sealed and there are no gaps or see-through areas?*
	  - *What could happen if there were gaps between the filters?*
	- While attaching the box fan:
	  - *Now we have to make sure the fan is facing a certain way, just like with the filter pads. Can anyone think of why this could be?* (Depending of the direction of the fan blades, air can either be drawn in via a drop in air pressure or pushed out)
	  - *Why do you think the fan blades are angled?*
	  If students struggle to understand, a test could be to hold a piece of paper toward the fan to see if it either is blown away or pulled near the fan.
	- Once the box fan is mounted onto the filter pad base:
	  - *Now that we have the box fan attached, can anyone think of anything we should check before we turn the box on?* (They need to seal the edges with cardboard and duct tape to make sure air can't leak out, since the box fan has curved corners instead of straight corners like the filters do)
	  - *How should we plug these holes so that it prevents particles in the air from leaking out, but also doesn't interfere with the fan's ability to work?* (This could be a good opportunity to test to see if they can come up with this engineering solution themselves)
	
	Adding to the summary table (see example Summary Table below in Part B):
	- Direct students to appropriate column and activity.
	- Students will come to consensus on how the task demonstrates the phenomenon.
	- Students will come to consensus on why this task is important for understanding the phenomenon.

Task #**3**: **Justice and Writing Wrap-Up** Day **3 (&4)** DCI: **3-5-ETS1.A:** Defining and Delimiting an Engineering	Agenda: - Reintroduce students to initial hypothesis - **Justice 12**: show students below picture and answer justice-centered questions (larger picture on last page):

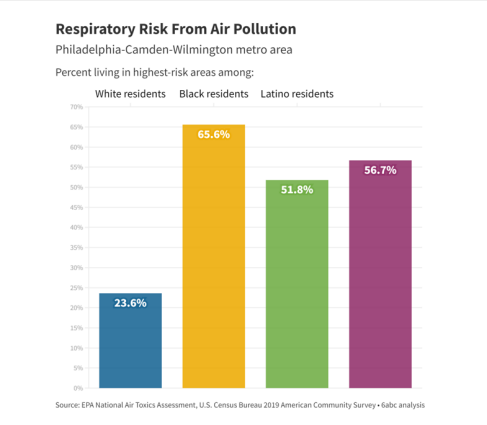
Problem

SEP:

- Engaging in Argument from Evidence
- Analyzing and Interpreting Data

CCC:

Patterns



***Fourth column represents *all* people of color

- Build consensus
- Complete summary table
- Create evidence-based explanation

Handout for students who may struggle to read graphs. This is intended to be practice and application, and can be easily modified for different levels of competency to match where students are in their understanding of graphs and physical representations of data.

Main tasks (include backpocket questions):

Reintroduce students to initial model:

- Questions:
  - *With what you know now, what would you change about your model?*
  - *What do you think your model demonstrated well that you would like to keep?*

Justice 12:

- Show students the EPA's infographic for the phenomenon's location, checking student understanding of the graph components (what does each bar represent?, which group(s) is/are most affected?, which group(s) is/are least affected?, what is the graph measuring?)
- Questions:
  - *What does this graph tell us and how?*
  - *What do you think about these differences?*
  - *What do you think not being able to stay outside for long periods of time, or open your windows, does to a person or community?*
  - *With what we know about air pollution, and from looking at this graph, how might you use one of these C-R boxes, or something similar?*

Build consensus:

- In class, students discuss what they have learned about the phenomenon and technology.
- Facilitate students to construct a "gotta have" list. These are consensus ideas about what must be included in their final evidence-based explanation. Draw on what students discussed when talking about what they would change about their models.

	Adding to the summary table (see example Summary Table below in Part B):
	- Direct students to appropriate column and activity.
	- Students will come to consensus on how the task demonstrates the phenomenon.
	- Students will come to consensus on why this task is important for understanding the phenomenon.
	
	Construct the explanation/analysis and propose suggestions:
	Lead discussion on how concepts learned about the Corsi-Rosenthal box can be used to help communities more gravely impacted by air pollution from industry.
	- Guiding question for instructor:
	  - *How can what we learned in building the C-R box demonstrate how communities are affected by large amounts of air pollution?*
	- Backpocket questions:
	  - *Think back to the video we watched; what were some of the main sources of air pollution?*
	  -
	Evidence-based Explanation:
	- Students will craft a written, evidence-based explanation answering the question: **How do we make clean air accessible?**
	- Students will be given sentence stems to help guide their thinking and to make sure they are using evidence if needed.
	  ○ For example: "Clean air can be made accessible by ____, which we learned by doing ____ which showed _____".
	- Students have the remainder of class period to write their explanations. Otherwise, the teacher can instruct that it be finished for homework.

Task (**Optional**)
Evidence-Based Explanation Workshop
 	
DCI:
3-5-ESS3.C: Human Impacts on Earth Systems
SEP:
Constructing Explanations and Designing Solutions
CCC:
Patterns
	Option One: Writing Analysis
	
	Launch task:
	This can be used to help students in learning to construct explanations, if they are not currently familiar with how to do so, by introducing them to an authentic example of an evidence-based explanation.
	
	Introduction or highlighting of science idea to reason with:
	- Students will be presented with an evidence-based explanation
	- Students can be prompted to take turns reading the passage about the presented scientific explanation
	
	Provide instructions to complete the task:
	- Students will read through the passage
	- Students will partner with a classmate and work to highlight (students could use three different colors, or use an organizer):
	  - Claim–*what is the author trying to say?*
	  - Evidence–*what evidence does the author present?*
	  - Reasoning–*how does this evidence support the author's message?*
	
	Resources:

	- Case Study
	- Evidence-based Explanation Passage
	
	Main task (include backpocket questions):
	Once students have looked through the passage with their partner(s):
	- Begin with question: *What did you learn in this passage? What did you take away from it?*
	- Class discussion–come to a consensus and record on a Docs or other projected document
	  - *What do we feel the author is trying to tell us in their writing?*
	  - *What evidence do they make sure to highlight?* Or *What evidence stood out to you?*
	  - *Do you think this evidence supports/confirms what the author is saying?*
	- Backpocket questions:
	  -
	
	Option Two: Writing Synthesis
	
	Launch task:
	This can be used to help students in learning to construct explanations by introducing a short, easily understood phenomenon related to this learning segment for students to experiment in their writing with.
	
	Introduction or highlighting of science idea to reason with:
	-
	Provide instructions to complete the task:
	-
	
	Main task (include backpocket questions):

PART B: Draft Summary Table. *Construct a draft Summary Table that includes each task, the intended understandings from the task, and how the task helps develop an explanation for the anchoring phenomenon. We suggest that responses are written as full sentences and no more than two sentences are included in each box. Adapt the table based on the number of tasks in the unit. While the goal is for students to come to consensus statements to be included on the table, having already thought through possible responses will make facilitating the discussion easier.*

Task	What we learned about the science ideas	How it helps us explain the phenomenon
Air Quality & Pollution	Air quality is affected by pollutants in the air such as gases and debris.	These pollutants in the air have an impact on human health that can affect their quality of life.
Air Filtration	Devices can be constructed to filter the air of particles such as pollutants.	Air filtration devices can remove pollutants produced by factories and industrial plants that people would otherwise breathe in.
Human Health	Some people live in areas with a higher concentration of air pollutants.	Areas with highly concentrated air pollution often coincide with vulnerable communities, leading to worse health outcomes for residents of these areas.

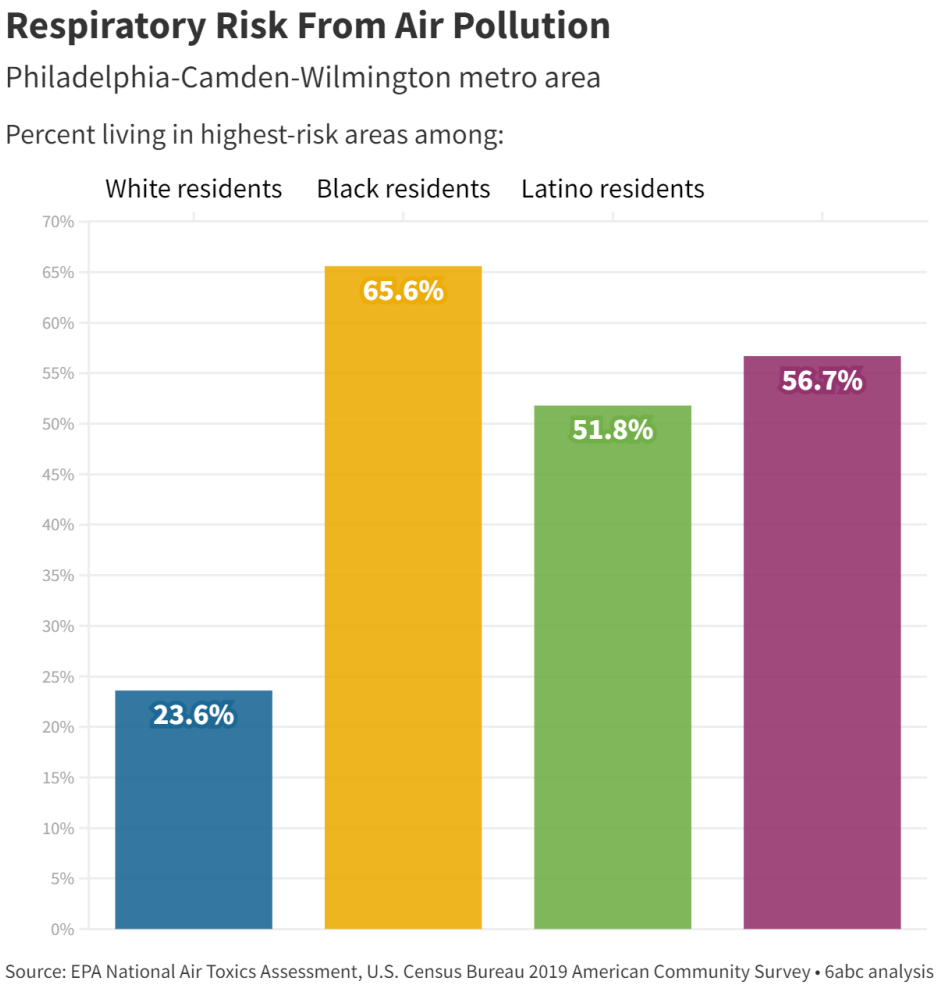


Image source: https://6abc.com/environment-inequity-race-racial-disparities/11152688/

*** The fourth bar in the above graph represents the average percentage of people of color living in highest-risk areas. The website allows the user to hover and see the full description of each bar represented in the graph***

UCONN

NEAG SCHOOL OF EDUCATION

Grade 8 Unit Plan

Authors: Aaron Richardson, Jannatul Anika, Todd Campbell
Unit Title: Corsi-Rosenthal Box Learning Modules
Science Area Focus: Physical Science, Life Science - Biology

Note: These instructional materials were co-developed by two graduate students and a professor/researcher in science education and in the Neag School of Education

Corsi-Rosenthal Box Learning Module:

How can we make clean air accessible for schools?

Unit Author(s):	Aaron Richardson, Jannatul Anika, David Todd Campbell
Unit Title:	Engineering for Air Quality
Science Area Focus:	Physical Sciences, Life Sciences–Biology

STAGE 1: PLANNING FOR ENGAGEMENT WITH IMPORTANT SCIENCE IDEAS

PART A: Unpack the Standards. *This is completed by reviewing the Framework for K-12 Science Education to identify the Disciplinary Core Ideas (DCI), DCI Progressions, and Performance Expectations that will make up the student learning targets of the unit.*

STEP 1. Based on the science area focus above, identify the appropriate **disciplinary core idea(s)** (DCI) [include both DCI (e.g., MS-LS2) and applicable **sub-DCIs** (e.g., MS-LS2A)]

LS1.A: Structure and Function: In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)
LS2.A: Interdependent Relationships in Ecosystems: Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
ETS1.A: Defining and Delimiting an Engineering Problem: The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (MS-ETS1-1) (secondary to MS-PS3-3)

STEP 2. Identify the relevant **performance expectations** that you are working toward.

Life Sciences:
- **LS2.A:** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. MS-LS2-1

Physical Sciences:
- **PS2.A:** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. MS-PS2-2

Engineering Design: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. MS-ETS1-1

PART B: Identify a Scientifically Rich, Complex Anchoring Phenomenon. *The anchoring phenomenon will serve as the real-world event that students work to explain as the purpose for engaging in the unit.*

STEP 1. Describe a **scientifically rich, complex environmental phenomena** that will require students to use multiple science ideas that are central to the DCI(s) to explain.

https://ctmirror.org/2022/08/09/ct-connecticut-schools-clean-air-hvac-human-right-mold/

Teachers in Fair Haven School spent their last month of summer vacation scraping mold off of the desks, tables, and various other pieces of furniture in their classrooms. This process is necessary to reduce the risk of health problems to students and the teachers themselves, because the school's heating, ventilation, and air conditioning (HVAC) system is too old and faulty to maintain proper air flow and temperature within the building. Mold infestations on furniture, as well as black mold infestations in the ceiling above the classrooms, have been reported due to the increased humidity and temperature, particularly as the state begins to experience its summer weather. This is not an isolated case. A teacher in another district two years prior had to take a leave of absence from the school premises. This was after receiving a stay-at-home order from her doctor due to the level of mold within the building. Much of the country's HVAC systems have not been maintained to allow their continued use, and so many have begun to fail to clean the air within school buildings, leading to epidemics like what Fair Haven faces today.

Temperatures within school buildings can easily climb to above 90 Fahrenheit without air conditioning during the summer and early fall months, leading some districts to have to close the building, or dismiss students early, until temperatures are back out of the health risk range. These early dismissals and school closings, along with the present mold and mildew problem within classrooms, lead to many possible disruptions to student learning.

A third of schools do not have the appropriate funding to replace or maintain their HVAC systems, and 39% of Connecticut districts have not approved any such funding. Many HVAC systems, like the one in Fair Haven School, are too old to continue to operate efficiently, and with systems as old as these, their continued maintenance and use cost more than would a replacement. However, this requires the approval of funding to replace HVAC systems with more up-to-date, efficient models. Schools and their faculty must find ways to reduce the harm done by these faulty or broken systems in the meantime.

STEP 2. List **resources** (websites, articles, books, etc.) that help you (i.e., the teacher) better understand the anchoring phenomenon:

1. **POSSIBLE SIMULATION ACTIVITY:**
   http://labs.minutelabs.io/Brownian-Motion/
   - **Accompanying video:** **https://www.youtube.com/watch?v=nrUBPO6zZ40&list=PLED25F943F8D6081C**

   http://physics.bu.edu/~duffy/HTML5/brownian_motion.html#:~:text=Brownian%20motion%20is%20the%20apparently,the%20path%20of%20the%20particle.
2. **AIR MOVEMENT AND FILTERS:**
   a. https://www.youtube.com/watch?v=WhiTlkZlwl4
3. **AIR PARTICLES:**
   a. **https://ncceh.ca/documents/evidence-review/do-it-yourself-diy-air-cleaners-evidence-effectiveness-and-considerations**
   b. Particle sources: https://www.cdc.gov/air/particulate_matter.html
   c. Particle pollution: https://www.epa.gov/pmcourse/what-particle-pollution and https://www.lung.org/clean-air/outdoors/what-makes-air-unhealthy/particle-pollution#:~:text=Fine%20particles%20
   d. EPA Air Quality Guide: https://www3.epa.gov/region1/airquality/pdfs/airqualityguideparticles.pdf
   e. Static Pressure: https://blog.orientalmotor.com/fan-basics-air-flow-static-pressure-impedance
4. **HOW A BOX FAN WORKS:** https://www.youtube.com/watch?v=qF7WHQRSHGU
5. **WORLD IMPACT:**
   a. https://www.whitehouse.gov/cleanindoorair/
      i. https://www.epa.gov/indoor-air-quality-iaq/clean-air-buildings-challenge
      ii. https://www.epa.gov/system/files/documents/2022-03/508-cleanairbuildings_factsheet_v5_508.pdf
   b. https://www.epa.gov/iaq-schools
   c. https://www.energy.gov/eere/buildings/efficient-and-healthy-schools
6. **Printout of the CR Box Construction Guide–** https://blink.ucsd.edu/_files/safety-tab/COVID-filter-system-poster.pdf
7. **HUMAN HEALTH**:
   a. https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm
8. **JUSTICE RESOURCES:**
   a. https://www.epi.org/publication/toxic-stress-and-childrens-outcomes-african-american-children-growing-up-poor-are-at-greater-risk-of-disrupted-physiological-functioning-and-depressed-academic-achievement/ **(it should be noted that this resource refers to the 'achievement gap', which is a concept that is outdated and rooted in a deficit approach to students, instead of regarding students as having unique sets of knowledge that they bring into the classroom with them)**
   b. https://www.aaihs.org/why-the-academic-achievement-gap-is-a-racist-idea/
9. **OTHER RESOURCES:**
   a. To give students an idea of the scale on which viruses such as the coronavirus exist: https://learn.genetics.utah.edu/content/cells/scale/
      i. Based on article: https://www.news-medical.net/health/The-Size-of-SARS-CoV-2-Compared-to-Other-Things.aspx#:~:text=How%20does%20it%20compare%20to,as%20large%20as%20500%20nm.
   b. https://cleanaircrew.org/box-fan-filters/
10. **ARTICLES AND RESEARCH:**
    a. Study on DIY Filters:

https://www.sciencedirect.com/science/article/pii/S0360132322011507

b. About Covid-19: https://www.cdc.gov/coronavirus/2019-ncov/your-health/about-covid-19/basics-covid-19.html#:~:text=COVID%2D19%20most%20often%20causes,some%20people%20become%20severely%20ill.
c. Latest Brown article on subject: https://www.brown.edu/news/2022-12-23/corsi-cubes-study
d. Rosenthal's article on the MERV 13 filter and Covid Box: https://www.texairfilters.com/how-a-merv-13-air-filter-and-a-box-fan-can-help-fight-covid-19/
e. https://ewa.org/data-research-tips/how-indoor-air-quality-in-schools-affects-student-learning-and-health#:~:text=Breathing%20polluted%20air%20harms%20students,air%20quality%20reduces%20cognitive%20ability.
Sources in above article:
   i. https://files.eric.ed.gov/fulltext/ED609665.pdf
   ii. https://iaqscience.lbl.gov/publications/ventilation-problem-schools
   iii. https://pubmed.ncbi.nlm.nih.gov/33091637/
   iv. https://jamanetwork.com/journals/jamapediatrics/article-abstract/2587681
   v. https://www.sciencedirect.com/science/article/pii/S0160412018324140
   vi. https://pubmed.ncbi.nlm.nih.gov/31310034/
   vii. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001792
   viii. https://www.nber.org/papers/w30061

STEP 3. Identify **technologies** (CS, AI, machine learning, etc.) related to the phenomenon and describe how the technologies listed above are used in solving the environmental problem:

COMPUTER TECHNOLOGIES:

a. **Brownian motion simulation:** http://labs.minutelabs.io/Brownian-Motion/ **–this simulation strongly recommended due to the ability to change mass and size ratio, and energy level.**

   http://physics.bu.edu/~duffy/HTML5/brownian_motion.html#:~:text=Brownian%20motion%20is%20the%20apparently,the%20path%20of%20the%20particle

MATERIAL TECHNOLOGIES:

a. **For C-R Box:**
   - 20-in. portable box fan–**Corsi recommends keeping the cardboard from packaging; this will be used to block holes that can cause air leaks**
   - 4 MERV 13 2-in. air filters
   - Duct tape
   - Scissors
   - User guide: https://aghealth.ucdavis.edu/sites/g/files/dgvnsk261/files/inline-files/DIY%20Air%20Purifier%20Directions_English.Spanish_0.pdf

STEP 4. Develop a **driving question** to frame the anchoring phenomenon for the students. State your driving question below. (**See Example Here**)

How can we make clean air accessible for schools?

PART C: Provide a Target Written Explanation. *The target written explanation serves as a resource for identifying which science ideas are important for explaining the phenomenon. After identifying the important science ideas, you can consider when and how these ideas are introduced and explored across the unit.*

Provide a **target written explanation** of the phenomenon. This should be written at the appropriate grade level. (Note: the explanation should identify how science ideas are coordinated to explain the occurrence or event that happened in the world).

In the United States today, nearly 41% of school districts need their HVAC systems replaced, repaired, or otherwise updated in at least half of the buildings within their district. Additionally, 28% of schools need roof replacements and repairs to keep moisture from creating mold and mildew infestations that can harm students and faculty. The spores of mold and mildew are among many potentially airborne particles–along with trace metals from nearby traffic, volatile organic compounds from construction materials and furnishings, bacteria, viruses, and particulate matter–that can pose a threat to student and faculty health.

Even before air pollutants–such as the mold found in Fair Haven School is taken into account–students of color have already been documented as having to overcome more obstacles to their education than their white peers. Because of historical practices (e.g., redlining) and unequal school funding models, they are disproportionately more likely to come from a family of low socioeconomic status, which exposes them to more stress such as food insecurity, homelessness, etc. This can leave many students without access to resources that would help them succeed in the classroom. When a high concentration of air pollutants, such as can be found in highly populated areas, is present, students and faculty in these areas are more likely to feel the effects of these pollutants on their health.

Health problems caused by air pollutants such as mold can range from asthma to cognitive abilities and emotional regulation due to brain inflammation in the presence of pollutants such as mold, can increase truancy, absenteeism, and academic ability. Higher air quality has been linked to better learning retention because of an increase in alertness, a drop in chronic absenteeism, and a drop in suspension rate. As many districts, as shown in the case of Fair Haven School in New Haven, CT, and Westhill High School in Stamford, CT, lack funding or the legislative support needed to acquire funding to restore their HVAC systems, Corsi-Rosenthal boxes can be a useful tool in bridging the gap in access to high quality air. The use of air filtering devices have been proposed as useful tools in offsetting the effects of faulty HVAC systems.

Understanding the properties of air is necessary to understanding how air particles and pollutants, such as mold and mildew, are able to impact human health. Firstly, Brownian motion is the random movement of particles in the air that is caused by collision with smaller, gaseous molecules. These collisions vary in degree of impact as well as frequency and direction, and can even be impacted by temperature and concentration gradients as molecules will tend to move from areas of high to low concentration–in this case gas dispersing into a room of a certain volume from a given point.

Specifically related to the Corsi-Rosenthal box, air pressure is the second property used by fans and air filtration devices to clean the air. The fan within the filter works by first creating low pressure inside of the filter, causing air within the air filter box or box fan to move outside. This change in air pressure causes air from outside of the filter box or box fan to move inside, to the area of lowest concentration. As this exchange continues while the fan runs, the air pressure equalizes in both the outside and inside areas, air from outside of the filter moves to the inside of the filter box or box fan and vice versa. Because areas of high pressure have more air particle collisions than areas of low pressure, more collisions between particles are possible in the space leading into the box due to the interaction between this air pressure difference and the Brownian motion of particles in the air.

Air purifiers use these mechanisms–Brownian motion of air particles and the pressure difference created by a filter's fans–to capture particles out of the air using a maze of walls that air moves through. While the fan continues to run, creating areas of low and high pressure for air molecules to

move between, the Brownian motion of the particles causes them to collide with air molecules as well as the maze of the filter pad so that eventually the particles can no longer avoid collision with the maze and are captured by the filter pad. The bigger the particle, the easier it is captured, which means that higher the quality of the air filter cartridge, the smaller the particle that can be captured by the air purifier.

PART D: Identify Science Ideas. *(REVISIT AND FINALIZE PART A: UNPACK THE STANDARDS). Using the target explanation above, identify the science ideas that are essential for explaining the phenomenon. After identifying the science ideas, identify at least one science task for each science idea as a resource that can be used during Stage #3.*

STEP 1. **Identify the science ideas** within the explanation that are central to students explaining the phenomenon.

Science Idea 1: Properties of air particles
Science Idea 2: Air filters and how they work
Science Idea 3: Engineering for human health

STEP 2. For each science idea identified above, **choose one task, reading, video, simulation, or investigation that will help students understand this important idea and begin to see its usefulness in explaining the anchoring phenomenon**. Do this for each science idea below.

Science Idea 1: Brownian motion and air pressure–ask students to watch https://www.youtube.com/watch?v=PzssJDZn9xI and come up with a simple model of how they believe these particles, when in the air, are able to seemingly move *and* stay suspended in the air
Science Idea 2: Impacts of air quality on human health–Day 2 class investigation and mini model
Science Idea 3: Air filters and how they work–building the Corsi-Rosenthal box

STEP 3. **PART E: Identify Social Justice and Equity Ideas**. *Identify the social justice ideas that are either central to supporting student engagement and connection to science (i.e., identity, diversity) you want to focus on during the unit or essential for explaining and taking action to resolve social injustices related to the phenomenon. After identifying the social justice ideas, identify at least one instructional strategy or task that will help you realize each social justice idea as a resource that can be used during Stage #3.*

STEP 1. **Identify the social justice ideas** that are central to supporting student engagement and connection to science (i.e., identity, diversity) or essential for explaining and/or taking action to resolving social injustices related to the phenomenon.

Justice 14–JU.6-8.14: I know that all people (including myself) have certain advantages and disadvantages in society based on who they are and where they were born.
Action 20–AC.6-8.20: I will work with friends, family and community members to make our world fairer for everyone, and we will plan and coordinate our actions in order to achieve our goals.

STEP 2. For each social justice idea identified above, **choose one instructional strategy, task, reading, video, simulation, or investigation that will help students understand**

this important idea and begin to see its importance in supporting their connection with science (i.e., identity, diversity) or for explaining and taking action to resolve social injustices related to the phenomenon. Do this for each social justice idea below.

Justice 14–JU.6-8.14: I know that all people (including myself) have certain advantages and disadvantages in society based on who they are and where they were born.

- **Task**–Students will read an article to investigate how schools in Connecticut are facing issues with poor indoor air quality that leads to an unsafe learning environment. In the article, they will learn how infrastructure is an integral aspect of supporting "the delivery of education" as well as how funding plays a role in this issue.

Action 20–AC.6-8.20: I will work with friends, family and community members to make our world fairer for everyone, and we will plan and coordinate our actions in order to achieve our goals.

- **Task**–Students will be learning how to design and construct a filtering device that can create clean air. In addition, they will understand the way in which their design or construction can be made as an affordable solution for communities to use and why this need for affordable devices is vital.

STAGE 2: NEGOTIATING IDEAS AND EVIDENCE THROUGH TASKS

The goal of the second stage is to support ongoing changes in students' thinking by providing learning experiences that help coordinate their own ideas with powerful ideas in science to build a scientific explanation of the anchoring phenomenon. This involves designing or adapting a number of purposeful tasks, coordinated with the important science ideas identified earlier, and the construction and use of public records such as a Summary Table to help keep track of ideas over time. Important in this stage is the revision and testing of the students' models. This stage makes up the majority of the unit as the class works to develop their explanations of the phenomenon through engagement in the practices of science.

PART A: Develop Unit Task Outline. *Provide the outline of each purposeful task that includes the introduction or highlighting of science ideas to reason with, the task launch, the procedures for the main task, and how the summary table will be updated. Each task may take one or more days. For each task, identify target Disciplinary Core Ideas (DCIs), Science and Engineering Practices (SEPs), and Crosscutting Concepts (CCCs) that will guide student sensemaking in that task. Also include an outside of how you will facilitate the mid-unit model revision.*

Purposeful Task	Outline*

Task #**1**:
Problems and Constraints
Day **1**
 	
DCI:
ETS1.A: Defining and Delimiting an Engineering Problem
SEP:
Asking Questions and Defining Problems
CCC:
Stability and Change
	Introduction or highlighting of science idea to reason with:
	
	Introducing the phenomenon:
	- https://ctmirror.org/2022/08/09/ct-connecticut-schools-clean-air-hvac-human-right-mold/
	- Students will read and discuss this article:
	  - Discuss HVAC systems
	  - Discuss effects of mold and mildew on health
	  - Discuss how, without the ability to repair or replace HVACs, air quality in classrooms can be improved
	
	Main task (include backpocket questions):
	
	Main task to be completed:
	1. Students will read and discuss article centering phenomenon (link above) and will cover **Justice 14** task.
	  (It may be suggested that students are made aware that this article was written by high school seniors, as a way to empower students about their ability to affect change)
	- Students will complete Guided Notes handout
	- Guiding questions:
	  - *What message did you take away from this article?* (**Identify problems**)
	  - *What stood out to you in the article?* (**Identify problems and constraints**)
	  - *Based on your observations, what factors seem to be at play?*
	  - *Where do you think the biggest/highest priority changes need to happen?*
	  - *Do you know what an HVAC system is?*
	  - *What do you know about HVAC systems?*
	  - *How does an HVAC system prevent mold and mildew from collecting on furniture?*
	  - *Why does a faulty, failing, or absent HVAC system cause mold and mildew to form?*
	  - *Based on the article, what can you tell me about why HVAC systems in Connecticut schools are no longer working, or not working well?*
	  - *Why do you think these systems have gotten to this point?*
	  - *What do you know about how mold and mildew affect human health?*
	  - *While there are these obstacles preventing these HVAC repairs, what is something we might be able to do to improve air quality in the meantime?*
	  - ***What does accessibility mean to you?***
	- Relevance to students' lives:
	  - *How does this article make you think of your own experience here at school?*
	  - *How do you think the air inside the classroom might affect you?*
	  - *Have you ever experienced trouble breathing?*
	  - *What brought on this trouble breathing? Was it something in the air?* (could lead to discussions about forest fires, humidity, air quality alerts, etc)

- Wrap-up question:
  Without the ability to fix an HVAC system, what could schools do to help increase their air quality?
  (**Brainstorming solutions**)

2. (*Optional)* Could demonstrate the school's own HVAC system if teacher has access to thermostat
   - Potential questions to ask students:
     - *What do you envision is happening now as the system is running?*
     - *How do you think this helps you and I work in the classroom?*
     - *Why do you think air quality is so important to us?*
     - *Do you have some form of HVAC system in your home?*
     - *How do you heat and cool your home?*

3. (*Optional–encompasses more than just mold as air pollutants*) Students will investigate the impacts to human health that air pollutants (capable of being captured by the CR box) have and discuss.
   - Using https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm
     - Handout to guide students' investigation of webpage (optional resource as it expands to talk about other air pollutants)

Adding to the summary table (see example Summary Table below in Part B):

What we learned: HVAC systems in public schools aid in proper air flow and prevents the build up of mold and mildew that can impact the health of students and faculty negatively. Health impacts of mold exposure can include respiratory illness as well as trouble learning and trouble regulating emotions.
How it helps answer the phenomenon: Because HVAC systems are out of date, and many school districts do not have the funding to update, different solutions must be made to reduce mold and other air pollutants, and to make sure students and faculty have clean air to breathe. Having clean air to breathe is necessary to keep building occupants healthy.

Task #**2**:

Filtration Devices

Day **2**

DCI:

PS2.A: Forces and Motion

SEP:

Developing and Using Models

CCC:

Systems and System Models

Introduction or highlighting of science idea to reason with:

Introduction:
Students will view https://www.youtube.com/watch?v=PzssJDZn9xI

Day will include:

1. Air particles
    a. Familiarize students with the size of air particles relevant to air filtering devices
    b. Familiarize students with particle properties relevant to air filtering devices
2. Fans and air pressure
    a. Familiarize students with how fans create a difference in air pressure to move air
3. Filters
    a. Familiarize students with how filters can remove air particulate matter from the air inside of the classroom

Main task (include backpocket questions):

Introduction:

- Introduce video https://www.youtube.com/watch?v=PzssJDZn9xI
    - Notes and observations log
    - Questions:
        - *What seems to be happening here?*
        - *What are your observations or interpretations?*
        - *How are these particles moving around?*
            - *How can something that isn't alive move?*
        - *What is the air composed of? What do you typically think of as being part of the air?*

Partner Work–Air particles:

- Students will construct a mini model with a partner for how particles stay suspended, as well as move, through air as seen in the video.
    - This model should include:
        - What causes particles to stay suspended
        - What causes particles to "move" throughout the air space
        - What interactions are happening
    - Guiding questions:
        - *How can these particles be moving?*
        - *What is the air made of?*
        - *What are these particles suspended in?*
        - *Do you think all or only some particles stay in the air?*
        - *How do you think these particles can be taken out of the air?*

Small Groups–Air pressure

- Students will use their mini model to answer the question of *"How can air properties be used to clean the air?"*

- Turn-and-talk to come up with an answer
    - Teacher will check answer before allowing students to move on and formalize their answer
- Could take a variety of forms depending on what skills a teacher wants their class to work on:
    - An expanded model that incorporates this new information into the existing model
    - A short essay that uses their knowledge of air particles and how fans use air pressure to move air
    - Can collect student group responses verbally and look for:
        - Commonalities/Differences
        - What students understand
        - What students feel they need more information on
        - Predictions/hypotheses
- Guiding questions:
    - *Remember when we discussed whether you and the other people in your household prefer to keep your home warm or cool?*
        - *How do you think an HVAC system works to cool the air? Warm the air?*
        - *What do you think is happening to the air when an HVAC system is running?*
        - *Why does the way an HVAC system runs warm or cool the air?*

Transition Question:
How do we remove these particles from the air?
(Turn-and-talk with a partner using what they have learned above)

Class Discussion–Fans

- Discuss what students talked about with their partner in the "Transition Question".
- Introduce this video: https://www.youtube.com/watch?v=WhiTlkZlwl4 (watch from **0:00 to 1:49**)
    - Guiding questions:
        - *Do you know what is meant by a sieve?*
        - *What is inertia?*
        - *How can we use these filter properties to clean the air?*
            - *Should we add something?*
            - *How should we use this in the classroom?*
            - *How can we make this as efficient as possible?*

Class Discussion/Building Consensus–Air filters

- As students have now discussed the properties of air and air particles, students have had the opportunity to discuss with a partner, and been introduced to how an air filter works, pose the transition question to the whole class:
    - *How do we remove these particles from the air?*

	- Prepare students for learning to build and understand an air filtering device the following class **Simulation (optional):** http://labs.minutelabs.io/Brownian-Motion/ Instructors will direct students to explore "nature of particulate matter" simulator linked in the introduction sections above, potentially with an accompanying worksheet. - This worksheet can be used as a guide for students to explore the various variables to manipulate: - Mass ratio - Size ratio–one note here: because of how much the air molecules outnumber the particles, it may appear that it is the molecules growing in size, so some students might need direction in order to think about the size of the *particle* versus the size of the *air molecules* - Energy - Guiding questions: - *How was the particle's movement affected by its size or mass compared to that of the air molecules around it?* - *What did you observe when the air molecules has more energy?* - *What could higher energy correspond with in nature? (That is to say, what could cause molecules to have higher energy–temperature is one example)* Adding to the summary table (see example Summary Table below in Part B): **What we learned:** The nature of particulate matter causes these air particles to collide at random with air molecules. Particles move from areas of high pressure to low pressure until the occupied space is of even pressure. While particles are in high pressure spaces, caused by the volume of air molecules, there are more collisions. This continues to happen until particulate matter is bombarded randomly into a lower pressure space where fewer collisions can move the particle around. **How this helps answer the phenomenon:** Air purifiers use these properties to clean the air. First, fans create an area of high air pressure and an area of low air pressure around the outside and inside of the fan, respectively. Second, as air moves from the high to low pressure, it proceeds through a filter that uses a complex series of mazes. Third, as these particles move, they are bombarded by air molecules around them, causing these particles to eventually become caught in the maze of the air filter, and be taken from the newly circulated air.
Task #**3**: **Engineering Construction** Day **3** SEP: **Constructing Explanations and**	Introduction or highlighting of science idea to reason with: **Introduction:** Students will review their models from the previous class and find common themes or designs **Warm-up:** Solidify student understanding of how air purifiers work by introducing them to this video Main task (include backpocket questions):

Designing Solutions	**Printout of the CR Box Construction Guide:**
	https://blink.ucsd.edu/_files/safety-tab/COVID-filter-system-poster.pdf
	
	Class Activity:
	- Construct CR Box as a class
	- Class discussion on:
	  - Limitations
	  - Potential improvements (such as increasing filter thickness, as discussed in the study on DIY filter efficacy in **Articles and Research** item '**a**', or using multiple filters per classroom and higher air flow rate, as also discussed in the aforementioned study)
	  - Students can also be guided in discussing how to supplement the CR box, such as with masks, or occupancy limits such as what was standard during the height of the Covid-19 pandemic
	  - Discussion of how to test the efficacy of the CR Box
	  - *The **Articles and Research** item '**a**' says that normally there are not well-studied ways for a person to test the efficacy of the filter, other than with a monitor such as a PM2.5 monitor, which would be expensive for a district to purchase. Still, discussion can potentially add to students' understanding of how to test their creations.*
	
	Build consensus:
	● Students will discuss what they have learned about this technology and the phenomenon this technology was designed to solve.
	● Students will investigate available air purifiers on the market and come to conclusions around accessibility of the C-R box
	  ○ Students will choose one of the listed suppliers and complete the handout
	
	● Guiding questions:
	  ■ *Based on what we know now, are there any ways in which you would improve this CR box?*
	  ■ *Based on observations we've made about the CR box, what are important things to consider when deciding whether to use one in the classroom?*
	  ● This could lead to a discussion about how there are tradeoffs that need to be considered such as:
	  ○ Noise level
	  ○ Effective air flow rate (low versus high settings on the box fan)
	  ○ Energy consumption cost
	  ○ Availability of materials
	  ■ *How can this technology impact communities in need?* –**Action 20** task along with the above handout
	
	Construct the explanation/analysis and propose suggestions:
	● Facilitate the writing of the evidence-based explanations based

around the driving question: **How can we make clean air accessible in schools?**

- Provided an example of an explanation of another topic as an example. One such example, from this unit– https://drive.google.com/file/d/18c2qZebQID9Go6SJ81LWOFxNUIOUN-S6/view centering the driving question: **In the cold water near the north and south poles, the formation of brinicles, or "underwater icicles of death", has been observed and recorded by scientists. How do the brinicles form, and why do they grow downward through the water?**

Target explanation of phenomena:

When seawater at the poles cools and freezes into ice that covers the surface, the salt from the water precipitates out so that the ice crystals can form. This means that the water around the forming ice has a higher salinity than the ice or the original seawater. This water gets trapped in the forming ice, but the high salt concentration depresses the freezing point so that the water is below normal freezing temperature but is still liquid.

As the ice moves/breaks, this super cold water escapes and sinks through the normal ocean water below the ice. It sinks because its high salt concentration and super cold temperature make it more dense than the surrounding water (and denser substances sink). As it sinks, the water around it freezes as it comes into contact with the super cold solution, creating a hollow tube of ice around the cold, high-salt solution. The brinicle will continue to form if the solution keeps flowing, meaning that they are sometimes small and sometimes very large and can take several hours to form. The growth flows downward from the surface because it follows the sinking solution.

- Students will be given sentence stems to help guide their thinking and to make sure they are using evidence if needed.
    - For example: "I learned _____ because in class we did _____ which showed that _____".
    - Another example (also fulfilling **Action 20** task): "This technology _____ can solve _____ because as we learned in class, it _____".
- Students may need time outside of the classroom to finish their evidence-based explanation.
    - This could also offer an opportunity for students to peer review and then correct their work into a more complete draft in the day following the assignment, should time or curriculum allow.

Adding to the summary table (see example Summary Table below in Part B):

What we learned: While many different air purifiers exist on the market, and many have similar efficacy to the CR box, with the understanding of how fans use a change in air pressure to cause collisions of air particulate matter into the filter material, air particulates that can be successfully removed from the air using homemade air purifiers.
How this helps answer the phenomenon: When compared to the air purifiers available on the market, this DIY air purifier is more cost effective and accessible for schools, making it easy to acquire supplies to make these even on a limited budget. Air purifiers have been shown to reduce the concentration of pathogens and air pollutants in the air, helping building inhabitants stay healthy. Particularly in school districts whose HVAC systems may be out of date or failing, the CR box provides a way to prevent molds and mildews from taking root in classrooms and on furniture or the ceilings of said classrooms.

PART B: Draft Summary Table. *Construct a draft Summary Table that includes each task, the intended understandings from the task, and how the task helps develop an explanation for the anchoring phenomenon. We suggest that responses are written as full sentences and no more than two sentences are included in each box. Adapt the table based on the number of tasks in the unit. While the goal is for students to come to consensus statements to be included on the table, having already thought through possible responses will make facilitating the discussion easier.*

Task	What we learned about the science ideas	How it helps us answer the phenomenon
Problems and Constraints	HVAC systems in public schools aid in proper air flow and prevent the build up of mold and mildew that can impact the health of students and faculty negatively. Health impacts of mold exposure can include respiratory illness as well as trouble learning and trouble regulating emotions.	Because HVAC systems are out of date, and many school districts do not have the funding to update, different solutions must be made to reduce mold and other air pollutants, and to make sure students and faculty have clean air to breathe. Having clean air to breathe is necessary to keep building occupants healthy so that learning can take place.
Filtration Devices	The nature of particulate matter causes these air particles to collide at random with air molecules. Particles move from areas of high pressure to low pressure until the occupied space is of even pressure. While particles are in high pressure spaces, caused by the volume of air molecules, there are more collisions. This continues to happen until particulate matter is bombarded randomly into a lower pressure space where fewer collisions can move the particle around.	Air purifiers use these properties to clean the air. First, fans create an area of high air pressure and an area of low air pressure around the outside and inside of the fan, respectively. Second, as air moves from the high to low pressure, it proceeds through a filter that uses a complex series of mazes. Third, as these particles move, they are bombarded by air molecules around them, causing these particles to eventually become caught in the maze of the air filter, and be taken from the newly circulated air.
Engineering Construction	While many different air purifiers exist on the market, and many have similar efficacy to the CR Box, with the understanding of how fans use a change in air pressure to cause collisions of air particulate matter into the filter material, air particulates that can be successfully removed from the air.	When compared to the air purifiers available on the market, this DIY air purifier is more cost effective and accessible for schools, making it easy to acquire supplies to make these even on a limited budget. Air purifiers have been shown to reduce the concentration of pathogens and air pollutants in the air, helping building inhabitants stay healthy. Particularly in school districts whose HVAC systems may be out of date or failing, the CR box provides a way to prevent molds and mildews from taking root in classrooms and on furniture or the ceilings of said classrooms.

UCONN

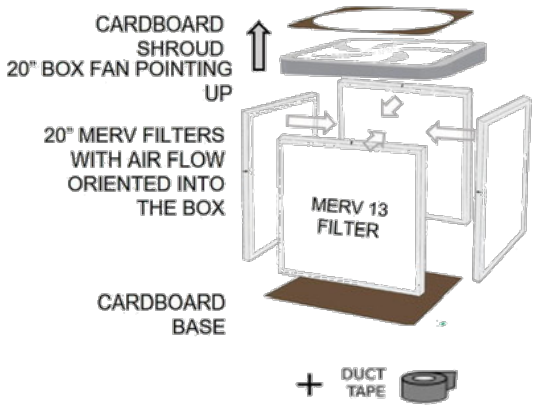
NEAG SCHOOL OF EDUCATION

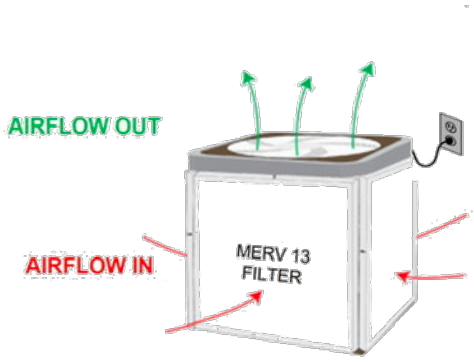
Girl Scout Lesson

Authors: Jannatul Anika, Aaron Richardson, Todd Campbell
Unit Title: Corsi-Rosenthal Box Learning Modules
Science Area Focus: Engineering, Physical Science

Note: These instructional materials were co-developed by two graduate students and a professor/researcher in science education and in the Neag School of Education

Do-It-Yourself Box-Fan Air Filter, the Corsi-Rosenthal Box





Background Resources :

- How to build a C-R Box

Scientific Themes:
Air quality and human health

Objective:
To understand the impact of airborne pathogens such as COVID-19 on human health, how COVID-19 spreads through the air using water aerosols, and how air filtration systems can be used for protection against these effects.

Students will learn about :

- What factors cause COVID-19 and other airborne pathogens to spread rapidly through human populations
- How air filtration helps to reduce the spread of COVID-19 and other airborne pathogens
- How air quality impacts human health and can allow the rapid spread of pathogens

Agenda:

- Open Discussion (15 minutes)
- Activity #1: Building the Corsi-Rosenthal Box (35 minutes)
- Activity #2: Reflection using Models (15 minutes)
- Closing the lesson (10 minutes)

Activity Details

Time Needed : 90 minutes

Materials :

- **For the C-R Box**
  - four 1" or 2" MERV 13 filters
  - 20-in box fan with box
  - 20" x 20" cardboard square (make from fan box)
  - Duct tape
  - Scissors
- **For the models**
  - Large paper
  - Markers
  - Scissors
  - Tape

Lesson Plan Outline

Open Discussion (15 minutes)

1. The lesson will begin with explaining to students what the objective of today's lesson is and asking a series of questions for students to begin thinking about the topic and/or assess their initial understanding.
   a. *"Today we will be learning about the importance of air quality and how it affects our health."*
      i. *Why do you think air is important to us?*
      ii. *How can the air get "dirty"?*
      iii. *What happens if we breathe in "dirty" air?*
2. The discussion on air will transition into the impact of the COVID-19 pandemic on communities by asking them the following questions :
   a. *What do you remember or understand about the COVID-19 pandemic? Is there anything that you're still experiencing from the pandemic right now?*
   b. *What are some of the challenges that are experiencing from the COVID-19 pandemic?*
   c. *What do you think about when you hear the phrase, "air quality"?*
      i. If the instructor notices students are struggling to respond, they may ask the following question to help elicit student responses : "Where do you see differences in air quality?" or "Where do you see differences in how the air looks or smells?". See if the students are able to make connections to their everyday lives such as being around smokers, being near a diesel truck, smelling spilled gas, etc.
   d. *How do you think "air quality" relates to the COVID-19 pandemic?*

Activity #1 : Building the Corsi-Rosenthal Box (35 minutes)

1. Begin activity asking the following questions :
    a. *Now that we've seen a demonstration of how far aerosols can travel, including staying suspended in the air, we want to understand how to reduce the spread*
    b. *Can anyone think of examples of where they've had to separate two things from each other?*
        i. When students give examples, make sure to ask the follow up question : *What is being separated from each other and what is causing the separation?*
        ii. If students are struggling with providing examples, the instructor may ask, "*Has anyone seen or used a strainer? Can you describe what you saw?"* or *"Does anyone have fish at home? Do you know what keeps the water so clean?"* These could be some leading examples.

2. After students have given examples, the instructor will begin explaining what the students will be building a Corsi-Rosenthal-box and the purpose of filtration.
    a. *This idea of separation is similar to the process of filtration. A filter is a device used to remove unwanted particles from something. For example, a strainer can help us remove the rocks from a mixture of rocks and water. Today, we are going to be building a Corsi-Rosenthal box which will be a filter that can help us reduce the amount of virus-containing aerosols in the air.*

3. Begin direct instruction on how to assemble the Corsi-Rosenthal box. Be sure to be explicit in stating that this is going to be an air filtration device where we are pulling air into the box and tiny aerosols, dust, pollen, mold are more will be trapped in the filter media. Prompting students for each part of the instruction will be important. Watch this video (https://indoorairquality.initiative.uconn.edu/build-your-own/) for a good step by step instruction that highlights how to prevent common errors while building. While building the components, the instructor will be asking the students questions to support their sense-making about how the CR box works.
    a. *We are going to start with building the "box" of the Corsi-Rosenthal-box. We are going to connect all four of the filters together. We want to make sure that the arrows on the filters are facing inwards and the filters are arranged to form a square, NOT a rectangle.*
        i. *Why do you think it is important for the filters to face inwards before we attach the fan? (the filters are not bi-directional)*

    b. *The next step is to make sure that the four filters are taped together and there are no gaps or openings all along the edges.*

        i. *Why do we need to make sure that the corners of these filters are sealed and there are no gaps or see-through areas?*
            1. We are trying to ensure students understand that air can go through these gaps. We want the air to be going through the filter. Highlight the path of least resistance.

ii. Next, cut out a 20" x 20" square of cardboard from the box the fan came from, and tape it to the **bottom** of the box.

iii. *Now we will be building the **top** of the box by attaching the fan.*

iv. *How does air interact with a fan?*

1. Check for students' understanding related to what the is - the slanted blades create a drop in air pressure as they spin that causes air from the higher pressure outside air into and through the fan. (Optional resources for instructors How Ceiling Fans Works & Electric Fan)

v. Ask students to test the fan by putting a piece of paper in front of it.

1. *Which side of the fan is "drawing air in" and which side is "drawing air out"?*
2. *What differences on each side of the fan may help with this?*
    a. Check for students' understanding that the fan blades are shaped in such a way that it draws air in and then pushes air out.

vi. After students have determined which way the air is flowing through the fan, ask the following question

1. *Which way do we think the fan should be attached to the filter box if we know COVID-19 particles are where we are standing?*
    a. Check for students' understanding that the fan should be positioned to pull air in from the surrounding area, through the filter media, into the box and the clean air exits the box from the top, propelled by the fan

2. Model for students on how to attach the fan. Show students where air might leak out. Instruct students that there will be a lot of duct tape used.

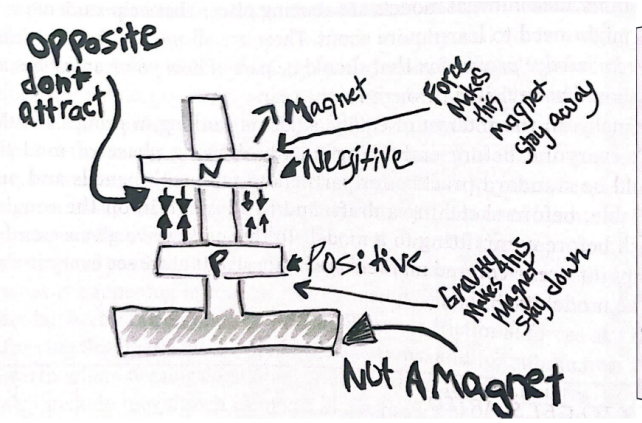
3. Ask the following question to help instruct students to add duct tape to their box.
    a. *Where do you think we may need to add more duct tape to avoid leaks?*
        i. Check for students' understanding that the corners of the box need to be taped to ensure that the only path the air can travel is through the filters, not through gaps.

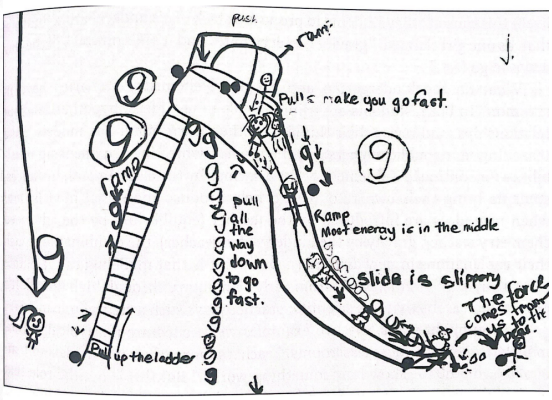
Activity #2 : Reflection using Models

1. After students have completed assembling their CR box, ask students to draw models to explain how the CR box works using the Modeling Template [Linked here]. Make sure to explain the purpose of why we are drawing models. While many types of models are possible (before/during/after, environmentally-based that include surroundings as well), the students will work to create a diagram that centers around the box and its anatomy.
    a. *Now that we've built a Corsi-Rosenthal box air cleaner, we are going to take some time to draw a model on how we think this box works. What happens inside and outside of the*

box to help reduce the spread of bad aerosols? Drawing models will help us visually see something that we don't normally see in our everyday lives. This will help us better understand what we built today and learned.

b. *Here is an example of a model (show image of model). Notice how there are drawings but also words to demonstrate how the person or group that created the model believes it works and to help other people who might see the model understand what the model is showing. We want to make sure in our model that we show what is happening inside and outside of our CR-box so that we have thought through what is important and so that other people can understand how a filter works and why it is important.*





2. Before allowing students to draw their own models in groups, advise students to make sure their model does the following
    a. Demonstrates the direction in which air is flowing
    b. Demonstrates why the air filters have to be facing a certain way (inward as indicated by arrows on the sides of their frames)
    c. Demonstrates an idea of what particles and pathogens might be pulled into the box
    d. Text explaining what is happening along each step for the journey of a pathogen going through the filter (text boxes or similar writing that could be describing that "here is where air is being pulled in by the fan" "air is being pushed out through filter" "particles are lodged/stuck in the filter material" etc.)
3. While students are making their models, instructors will walk around and ask questions to help students create their models. The following questions can be asked to help the students if they are struggling
    a. For students trying to show air flow, some ways of asking about it could be:
        i. *What are some ways to show that air is moving?*
        ii. *How might you tell your audience what is happening in this part of your model?*
        iii. *Now that you have shown the direction of air movement, how can you describe in words why it is important we know this?* (can be used to lead students to labeling parts of the diagram with text or text boxes to show their understanding of the process)
        iv. *What is something important that we talked about with air flow? How should it be moving?* (asking about direction)

v. *Why is it that the filter has to be facing a certain way? Could you talk more about this in your model?*

b. For students drawing the box, who seem to be struggling to label the parts or materials of the box, some possible questions could include:
   i. *I see you have finished drawing the box, do you remember some of the materials we used to put it together?*
   ii. *For these materials, could you describe to your audience why they are important for building the box?*
   iii. *I see you have finished drawing the box, what are some things about the box that you think are important to know?*

c. For students who have drawn the box, labeled it, and also demonstrated air flow components, and are now onto thinking about particles and pathogens:
   i. *So now that you have shown us how air is flowing, and that the filter is facing a certain direction, can you show us why it has to be this way?* (can lead back to or be used to reinforce question a-v if student is still struggling)
   ii. *So you know that the filters are designed to separate pathogens and particles from the air, can you show us some of these with your model?*
   iii. *I see you have added some air particles and pathogens like Covid around your box, can you describe how the filter is taking them out of the air? Why is this important to know?*

Closing the lesson (10 minutes)

1. Ask students to switch models with another group to observe the similarities and differences in their models.
2. After students have looked at another model, ask students : *What did you learn about from today's activities and the models?*
3. Encourage students to share with their families what they did today, learned, and ask family members what they think about their models and what they might add, if anything.