UCONN

INDOOR AIR QUALITY INITIATIVE

Cleaner Classroom Air

Mini Lesson Series
Grade Level: 3-5

Overview: This lesson series is meant to compliment the implementation of Do-It-Yourself air purifier. The lessons introduce indoor air quality and focus on the Science and Engineering Practices (SEPs) such as asking questions, analyzing data, and communicating information. The lessons can stand on their own or be adapted to supplement curricular units.

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Background Information

Indoor air quality matters, because we spend about 90% of our time indoors. Things in the air such as particulate matter (PM) and airborne viruses such as COVID-19 can have negative impacts on human health, especially for younger people whose respiratory systems are still developing and older people who often spend even more time indoors. Many factors influence indoor air quality, including temperature and relative humidity. Indoor air quality includes pollution from outside such as wildfire smoke, emissions from vehicles, and ozone.

More information can be found at EPA Indoor Air Quality in Schools

While commercial air purifiers exist, a DIY air purifier can be built using inexpensive materials, including a box fan, four MERV filters, cardboard, and duct tape. The fan pulls air through four standard HVAC filters that catch airborne pollutants. The DIY air purifiers reduce the amount of particulate matter and airborne viral particles. Design criteria for an air purifier include effectively filtering airborne viral particles, dust, allergens, and particulate matter. Constraints include cost, size, noise, and time. Classrooms are a unique challenge, because there are more people than in a home or a typical office, and students need to be able to hear their teacher and classmates. Schools do not have unlimited budgets, and commercial air purifiers are expensive. This makes the DIY option a more accessible option.

More information can be found at the Corsi-Rosenthal Foundation website

Lesson Series Overview

The four mini lessons below are sequential, but they do not need to be done four days in a row. Having students collect and analyze air quality data can be a longer-term project, depending on time and school curriculum. The lessons offer a brief introduction to indoor air quality and how air purifiers work, as well as practicing multiple SEPs.

Lesson Series Outline

1. Introduction to Air Quality
    a. Students will be introduced to air quality. Then they will define the design problem, listing criteria and constraints for the solution.
    b. SEPs: asking questions and defining problems; analyzing and interpreting data; constructing explanations and designing solutions
2. Building the air purifier
    a. Students will build an air purifier. Students carry out investigations using tissues and plan a simple investigation.
    b. SEPs: asking questions; planning and conducting investigations
3. Analyzing Data
    a. Students analyze and interpret data from the air quality monitor. Students graph and interpret data from their investigation planned during lesson 2.
    b. SEPs: analyzing and interpreting data; using mathematical and computational thinking
4. Sharing the Results
    a. Students will communicate their findings to the community.
    b. SEP: constructing explanations and designing solutions; obtaining, evaluating, and communicating information

Lesson 1: Air Quality

Driving Question

What is indoor air quality and why does it matter?

Student Learning Objectives

- Students will be able to define an engineering design problem, identify criteria and constraints, and analyze relevant data.
- Students will ask questions that can be investigated through experimentation.

NGSS Performance Expectations

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.

NGSS Science and Engineering Practices

- Asking questions and defining problems
- Analyzing and interpreting data
- Constructing explanations and designing solutions

Materials

ES 3-5 Slides.pptx, 3-5 Student Worksheets.docx

Lesson Sequence

1. Engage: Think-Pair-Share
    a. "Do you think about the air you breathe? Have you ever?"
        i. Prompt students with images of dust, pollen, masks, smog, wildfire smoke, etc

    b. After a short discussion, students write 3 things in the air
2. Explore: Notice and Wonder about gif from CR foundation
    a. As the visual is displayed (play on loop), students should write what they notice and wonder.
    b. "This is a model. What do you notice? What do you wonder?"
3. Explain: Indoor Air Quality: Show the first 1:27 of the video Clean Air for Everyone.
    a. Question prompts (depending on prior content)
        i. How might the air around us affect our health?
        ii. How do our bodies take in air? Where does air go when it is inside our bodies? Why does that matter?
        iii. Is air matter? What is in the air?
    b. "Indoor air can have bad things floating around in it, but there are ways to capture some of the bad things. We want to make our air cleaner."
4. Engineering design
    a. "We are going to work together to think like engineers! Engineers define problems in order to create solutions. What is the problem we want to solve?"
        i. In small groups, students discuss and write/draw the problem
    b. "Engineers have to make sure their solutions will actually work, so they brainstorm criteria and constraints. Criteria are the things required for success. What does the solution need to do?"
        i. It needs to filter the air. More specifically, it should catch the bad stuff.
    c. "Constraints are the limitations or restrictions. Can you think of some constraints?"
        i. It can't be too big or too expensive. It shouldn't make too much noise.
5. Air quality monitor: Measuring air
    a. Make predictions. "What is this device? What does it tell us? Why do we have it?"
        i. The air quality monitor measures multiple factors that influence air quality. It provides some of those measures (temperature, relative humidity, etc), as well as the air quality index, a number calculated from multiple factors.

The school has multiple air monitors to determine the indoor air quality.

b. "What does this measure? Let's label a few important parts."
    i. Students label the parts of the air quality monitor on the worksheet: temperature, air quality index,
c. Making inferences: "What do you think the colors and faces mean?"
    i. Green means good, clean air. Yellow means dirtier air.
    ii. "Let's compare the indoor and outdoor air. Which number is bigger? Do we want AQI to be higher or lower?"
    iii. The number is the AQI. We want it to be lower. The higher it is, the more bad stuff in the air

6. Collecting baseline data
    a. Students can collect initial data from the air quality monitor in multiple ways
        i. Data table on the student handout
        ii. Data collection form (data is compiled in spreadsheet)
        iii. IQAir's AirVisual Dashboard (districts will have an account and login)
    b. This step does not need to be done by the whole class. One student could travel to each air monitor, record data, and share with the class.
7. Closuring discussion
    a. "What is something we did today to be like engineers?"

Possible Connections

CCSS ELA

CCSS.ELA-Literacy.CCRA.R.1

Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCSS.ELA-Literacy.CCRA.R.7

Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

Lesson 2: Building an Air Purifier

Driving Question

How can we improve our classroom's air quality?

Student Learning Objectives

- Students will be able to explain how the air purifier cleans air.
- Students will be able to ask testable questions and plan an investigation

NGSS Science and Engineering Practices

- Asking questions and defining problems
- Planning and carrying out investigations

Materials

ES 3-5 Slides.pptx

3-7 kits for building the DIY air purifiers,

Tissue/toilet paper,

Scissors

3-5 Student Worksheets.docx

Lesson Sequence

1. Engage: Show picture of DIY air purifiers
    a. What do you think this device does?
    b. What were some of the criteria and constraints that we brainstormed during the last air quality lesson?
2. Building
    a. Today we are going to build an air purifier!

b. Assign roles to students (depending on class size and number of groups)
    i. Adhesive engineer - cuts strips of tape, helps tape edges, and cleans scissors after
    ii. Sustainability Coordinator - cuts cardboard square, ensures waste is disposed of correctly
    iii. Quality Control Engineer - checks filter direction, looks for gaps in tape
    iv. Project manager - keeps track of time and materials, can also help assemble as needed
    v. Additional roles as needed
        1. Photojournalist – take photos and write captions
        2. Art director – gathers materials for and plans decoration
c. Play video and pause after the box fan is taped to the box, then play video from the beginning, pausing to let students follow each step
    i. Gather materials. Take fan out of the box and make sure it works.
    ii. Cut a 50.8 cm x 50.8 cm square from the cardboard box (approximately the large side of the box).
    iii. Assemble the air filters (arrows face in, must be square). Tape edges.
    iv. Tape cardboard square to top of filters. Flip it over (the cardboard is the bottom of the box)
    v. Tape fan to the filters. Be sure the fan will blow air up!

3. Investigation: Is *all* the air being filtered?
    a. Conduct tissue test: *Use tissue, toilet paper, or steamers. While the fan is off, lay the tissue on the fan. The tissue will float when it is above the fan blades. At the corners, the tissue will get "pulled in," because the fan is pulling air in without the filter being in the way. The tissue will fall in the middle where the plastic is holding the fan blades, but the fan isn't "pulling" the tissue into it.*
        i. Where is the clean air leaving the fan?
        ii. Where do we want the dirty air entering the fan?
        iii. Can air sneak in without going through a filter?
    b. Use tape to close off areas where air can sneak in

4. Planning an investigation
    a. Students can plan an investigation using the air monitors or observing the filters. They can choose variables, outline a procedure, and determine what data to collect.
    b. Possible variables include location in the classroom, fan speed, number of students in the classroom, etc.
5. Closing discussion
    a. What is the purpose of the DIY air purifier?
        i. Cleaning the air. The fan pulls dirty air through the filters and pushes clean air out into the classroom.
    b. What is the purpose of the shroud?
        i. Shroud blocks dirty air from getting into the fan without going through the filters.

Possible Connections

Modeling

5-PS1-1.

Develop a model to describe that matter is made of particles too small to be seen. *Students can develop a model of the CR box and the particles it traps from the air.*

Testing the Design

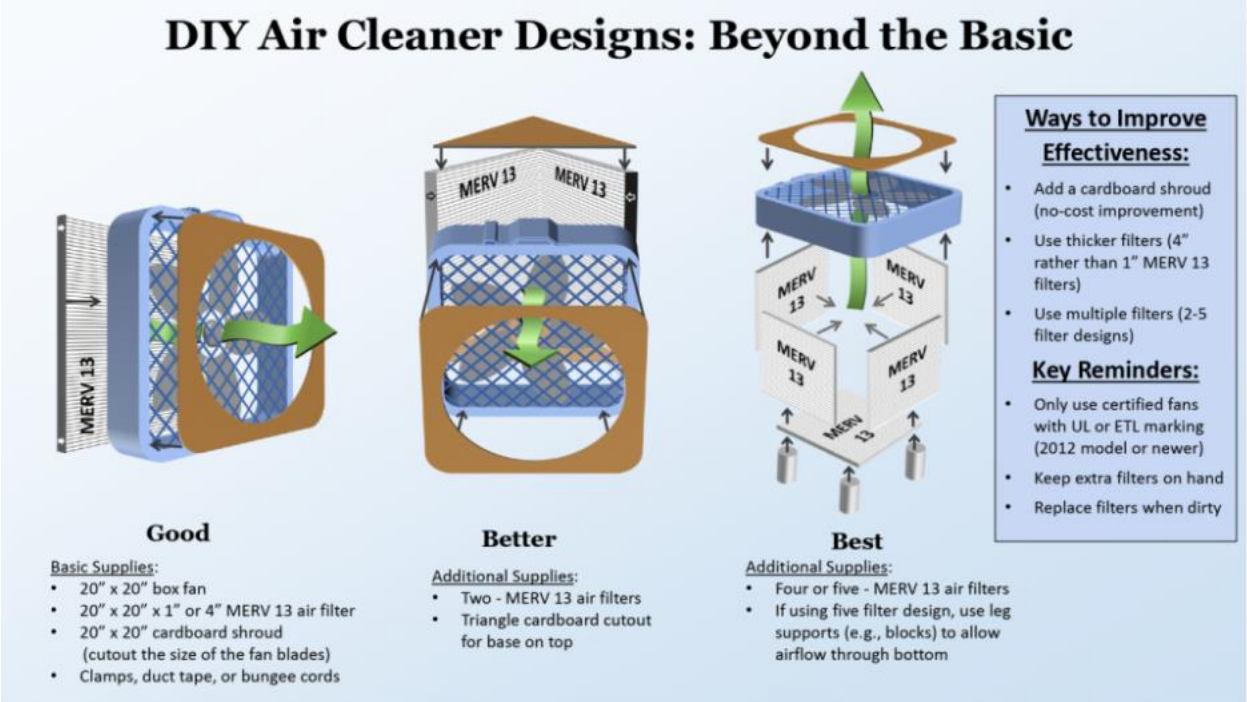
4-PS3-4.

Apply scientific ideas to design, test, and refine a device that converts energy from one form to another, and SEP4 Analyze data to refine a problem statement or the design of a proposed object, tool, or process. *Students can test how the fan speed affects the motion of a streamer or tissue placed on top of the fan.*

Comparing Solutions

3-5-ETS1-2.

Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. *Students can evaluate and test different designs for a DIY air purifier.*



3-5-ETS1-3.

Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. *Students can analyze air quality data when the fan is at different speeds, with and without the shroud, or at different locations in the room.*

Social Studies: Assembly Line vs. Craft Production

The class could be split into two groups where some of the teams use an assembly line approach, and some could use the craftsman approach. Students could compare the strengths and weaknesses of each.

Lesson 3: Analyzing Data

Driving Question

Is the air getting cleaner?

Student Learning Objectives

- Students will be able to transform raw data into a visual representation.
- Students will be able to explain the trend in air quality over time.

NGSS Science and Engineering Practices

- Analyzing and interpreting data
- Using mathematical and computational thinking
- Constructing explanations and designing solutions

Materials

ES 3-5 Slides.pptx, 3-5 Student Worksheets.docx

Lesson Sequence

1. Look at the data ahead of time and consider unexpected results (hopefully, the air quality improves over time)
    a. Air quality stayed the same: It's possible that the location of the air monitor has proper ventilation or that the school has an efficient HVAC system. This is particularly true if the initial readings were quite low (AQI < 15) because the monitors are only sensitive down to a certain point.
    b. Air quality worsened: There could be other factors impacting levels in the classroom. The outdoor air quality might be worse, or the classroom is much more active on the day the air purifier was running.

2. Think-Pair-Share
    a. What is the purpose of the air purifier?
    b. What data can we collect to determine if the air purifier is working?
3. Collect and transform raw data
    a. Observe the color of the filters on the air purifier.
    b. Raw data from one or more air monitors.
    c. Graph by hand or spreadsheet
4. Claim, evidence, reasoning
    a. What does the data tell us? Write a claim.
    b. What evidence do we have to support the claim?
    c. What is the reason behind the claim? *Why* are the data like this?
5. Closing discussion
    a. Who would want to know about these results?
    b. How might we present the results to that audience?

Possible Connections

Life Sciences/Health: How has the DIY air purifier affected students?

Students can brainstorm how they might determine whether the DIY air purifiers are improving student learning and health.

Lesson 4: Sharing the Results

Driving Question

Who cares about the air?

Student Learning Objectives

- Students will be able to communicate scientific information to a specific audience.
- Students will be able to argue with evidence in writing.

NGSS Science and Engineering Practices

- Constructing explanations and designing solutions
- Obtain, evaluate, and communicate information

Materials

ES 3-5 Slides.pptx, 3-5 Student Worksheets.docx

Lesson Sequence

1. What is science communication and why does it matter?
    a. Scientists and engineers work on real-world problems and need to communicate their findings to a wide range of audiences, not just other scientists.
    b. How do scientists communicate complicated information?
2. Introduce RAFT activity. Students can choose their audience and format, but they should justify their choice.
    a. Role: student
    b. Audience
        i. Parents
        ii. Principal
        iii. Politicians

        iv. UConn researchers
    c. Format
        i. Social media post(s) or campaign
        ii. Letter
        iii. Presentation (slides)
        iv. Infographic
        v. Report
    d. Topic
        i. Indoor air quality
3. Gallery Walk
    a. Have students share their RAFT products with each other!
4. Exit Ticket: How has your thinking about air quality changed?
    a. I used to think _____. Now I think _____.
5. *The final products from the RAFT should be shared with their intended audience if possible!*

Possible Connections

Persuasive Writing

CCSS.ELA-LITERACY.W8.1

Write arguments to support claims with clear reasons and relevant evidence.