

Air Quality Unit Outline

Lesson	Title	Time
1	Introduction and Empathy	1 day
2	Defining the Problem	1 day
3	Ideate	2 days
4	Prototype and Building	3 days
5	Testing	1 day
6	Presenting and Reflecting	2.5 days

Summative Rubric

	Below Standard 1	Developing 2	At Standard 3	Score
Design Thinking:				
Establishing Empathy	*Has limited to no recognition of the needs of the end-user	*Has a basic recognition of the needs of the end-user	*Has an understanding of the end-user's needs and insight into the end user's interests	
Defining Problem and Ideating	*Does not define the problem, research, or come up with solutions for the problem	*Defines the problem but does not adequately research or come up with multiple solutions for the problem	*Defines the problem, researches the problem, and as a group comes up with multiple solutions for the problem	
Prototyping and Testing	*Does not have a prototype or drawing from each group member, and the prototype does not filter out at least some particulate	*Develops a prototype (but not all group members have one), but prototype does successfully filter out some particulate	*All group members develop a prototype, and the chosen prototype filters out some particulate	
Collaboration:				
Is responsible for their portion of work	*Is not prepared *Does not do their assigned tasks	*Is usually prepared *Does project but often needs to be redirected	*Is always prepared *Always completes tasks on time without having to be reminded	
Works as a team	*Is not kind and does not consider the needs of the other team members	*Is usually kind and usually considers the needs of the other team members	*Is kind and always considers the needs of the other team members	

Product Creativity:				
Originality	*Product is a copy of something seen in research or based on another team's work	*Product has evidence of some new ideas	*Product is novel or new and is unique	
Creativity	*Product lacks imagination and innovation	*Product meets criteria and constraints and meets the basic purpose of solving the problem	*Product meets the needs of the end-user with innovation and imagination	
Presentation:				
Explanation of Ideas	*Presentation includes minimal elements of how the team used the Design Thinking Process to develop the final product	*Presentation includes most elements of how the team used the Design Thinking Process to develop the final product	*Present includes all elements of how the team used the Design Thinking Process to develop the final product	
Participation of Team Members	*Not all team members participated in the presentation	*All team members participated, but participation is not equal	*All team members participated equally and can answer audience questions	

Total Score: _____/27 ☐

Lesson 1: Air Quality- Introduction and Empathy

Time: 1 day (approximately 40 minutes)

Question: *Tell students that they do not have to share this information if they do not feel comfortable. How many of you have asthma?*

- Calculate class asthma data by taking the number of students/ total, times 100. This will make a percent (MATH).

Developing Empathy and Background Information for Students:

- Show video of people in India. The video is in the middle of the article and it is 360°.
 - <https://www.citylab.com/environment/2018/08/gasping-for-air-in-indias-industrial-north/567254/>
- Read article from students in New Delhi, India written to Mrs. Alcorn's STEM class.
 - <https://docs.google.com/document/d/15JwiKPigmVtfJx8jlu60EhBpSEwrGFfepdVvGUX6AF8/edit>

Discussion Tool and Assignment:

- Empathy Map (Graded- 5 points)
 - <https://www.nngroup.com/articles/empathy-mapping/>

Students “buy-in” when the problem is authentic. Have students complete the empathy map by recording two items in each box.

- **Says Box:**
 - Words that are physically said.
 - Said from article or video.
- **Thinking Box:**
 - Opinions about what they may be thinking.
 - What are they thinking, but not saying out loud?
- **Feels Box:**
 - What are their emotions?
- **Does Box:**
 - What are they physically doing?
- **Goals Box:**
 - What are the goals of the design that will improve the outcome for the user?
 - Goals for how you can help the user.

Goals for the air quality project are to:

1. Make air filters that would stand extreme pollution out of cheap and simple materials.
2. Communicate with the people in India and/or raise awareness about air quality.

Lesson 2: Air Quality- Defining the Problem

Time: 1 day (approximately 40 minutes)

Defining the Problem

1. Use the “Define Problem” sheet to discuss the air quality problem more in-depth.
 - a. Have students complete the first line of each question by themselves. The category is called “Your Response.” This should take about 5 minutes.
 - b. After students complete the first line, have them discuss answers with their team. Fill in “Team Response.” This should take about 5 minutes.
 - c. At the end, discuss answers as a class. Use the answer key worksheet to go over answers with students.

Problem: *To help filter the air for people in New Delhi, India to prevent them from suffering from health issues like asthma?*

2. After the problem has been analyzed, students will begin to research ideas. The idea of the Engineering Design Process is to begin with broad ideas and then narrow students’ thoughts based upon engineering constraints, materials, and other limitations that may arise.



Source: <https://upviral.com/funnel-mapping-tools/>

Lesson 3: Air Quality- Ideate

Time: 2 days (approximately 80 minutes)

- Half a day to play “Disruptus”
- Half a day to research
- Full day to explain and write a CER

Ideate Introduction:

There are two ways to ideate in the engineering design process.

1. Think of creative ideas.
2. Research ideas and summarize your findings.

Ideate Step 1: Think of Creative Ideas

- Have students play the game “[Disruptus](#).” Follow the handout of rules and explain the rules and categories to the students.
- Game setup:
 - Handout the game rules and categories to each group.
 - Handout approximately 10 cards to each group.
 - Handout a half sheet of blank paper to each member. Be sure each member has a writing utensil.
- Students can play a few rounds of “Disruptus.” Students move through rounds quickly; therefore, the game is only needed to be played for approximately 10-15 minutes.
- At the end of the game, have students share one invention that they created from the game.

Ideate Step 2: Research

- Have one student in each group make a Google Doc. There is a link to a Google Doc on Canvas titled “Air Quality Group Research” for the students to copy as a template. The one student with the Google Doc will add each member of the group onto the Google Doc by hitting the share button and typing in each student’s email address
- Each student must find at least one source for a minimum of three sources per group. They need to search possible ways and materials to use to make an air filter. As of now, allow students to think big and creatively. Many websites provide information of needing a fan, but students will not be able to make an air filter using electricity, batteries, or solar power. Encourage them to focus on the basic materials needed to make a filter without needing a power source.
- After research, students will summarize their findings in a claims, evidence, reasoning paragraph (CER)- Graded for 10 points.
 - <https://www.edutopia.org/blog/science-inquiry-claim-evidence-reasoning-eric-brunsell>
- It is easier for students to breakdown a CER paragraph.

- Note: 6th grade students may use a CER outline. 7th/8th grade students are capable of writing paragraphs without an outline. Utilize the CER outline for students who may need additional support.

Lesson 4: Air Quality- Prototype and Building

Time: 3 days (approximately 120 minutes)

- One day to create a rough draft prototype
- One day to peer review and fix prototype
- One day to build

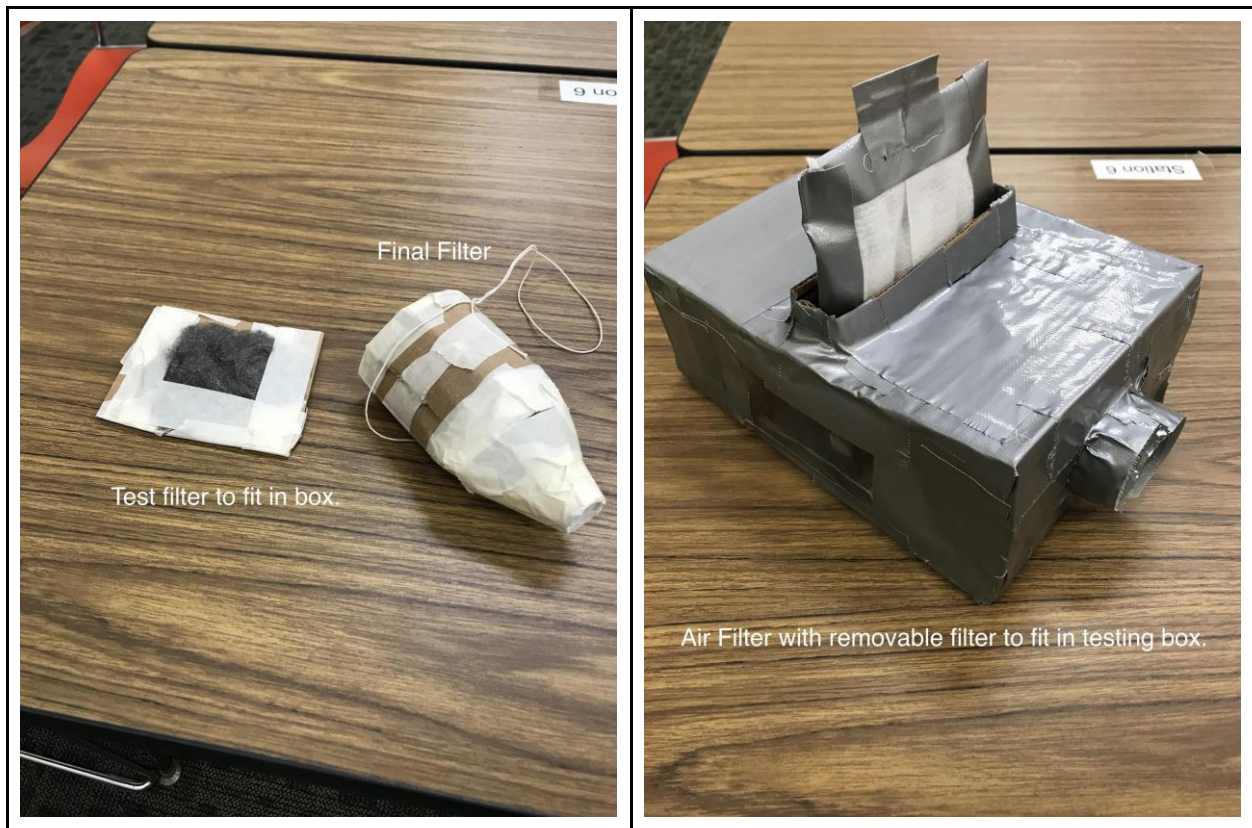
Prototype Step 1: Rough Draft Prototype

- Each person in the group needs to make a prototype of an air filter. Encourage students to use simple materials in their prototype. This is a rough draft prototype so allow students to still think of creative and big ideas.
- Students can make a prototype using the following tools:
 - Paper, pencils, and colored pencils
 - Auto Draw (autodraw.com)
 - Google Drawing
- After they have their prototypes created, have students record materials and upload a photo onto the Google Doc.

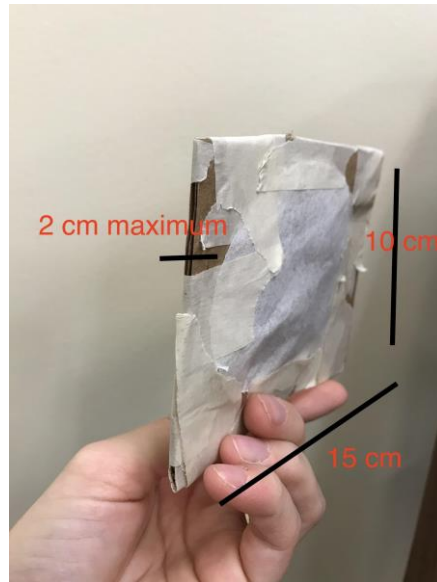
Prototype Step 2: Engineering Constraints

- After making a rough draft prototype, students were informed of their engineering constraints.
 - Limited Materials
 - Removable Filter
 - Filter Measurements
- Limited Materials:
 - Pipe cleaners
 - Gauze
 - Cotton balls
 - Coffee filters
 - Duct tape and masking tape
 - Elmer's glue
 - Staples
 - Rubber bands
 - Cotton t-shirts
 - Cardboard

- Styrofoam cups
- Scissors
- Rulers (to measure for test filter)
- Removable Filter:
 - Filters need to be removable for testing. Some students had to make a separate test filter if their final product did not allow for a removable filter (examples below):



- Filter Measurements:
 - Filters HAD to fit inside the testing box which was 15 centimeters long, 10 centimeters tall, and 2 centimeters thick.



Prototype Step 3: Peer Review Prototype

Note: For the peer review, encourage students to be constructive, but positive. Only write comments that could help someone make their prototype better.

- Now that students are aware of their engineering constraints, they will peer review and offer feedback to other classmates on how they can make their filter fit within the requirements and still be effective.
- Each student will set their iPad or Macbook out onto their desk. Place sticky notes at each desk. Each student will need a writing utensil.
- Students will write on the back of a sticky note and place it on the desk next to the person's computer to hide their comments.
- Students will rotate stations to see each prototype. Students were given 2 minutes at each station. They needed to provide feedback to at least 2 students at each station.
- Students were able to see their feedback after the peer review.

Prototype Step 4: Final Prototype

- Students will work with their group to consider feedback from the peer review and engineering constraints to make a final prototype for the group.
- Final prototypes can be created using:
 - Paper and pencil
 - Auto Draw (autodraw.com)
 - Google Drawing
- On the "Air Quality Prototype" Google Doc, students need to record their final prototype. Include materials and a picture of the final prototype. Each student needs to have the final prototype. Students can do this by sharing one student's Google Doc with the final product or recording materials and including an image on their individual prototype documents.

Building:

- Students were given one day to build air filters.
- Groups were called one at a time to gather materials for their air filters.
- After they were built, students left their air filters on the book shelf in the classroom. They did not leave the classroom (even if they were not finished).

Lesson 5: Testing

Time: 1 day (approximately 40 minutes)

Testing Step 1:

- Each group will test their air filter one at a time. Read below for what groups did while they were waiting to be tested or finished with testing.
- Use testing apparatus (show box) to test each filter.

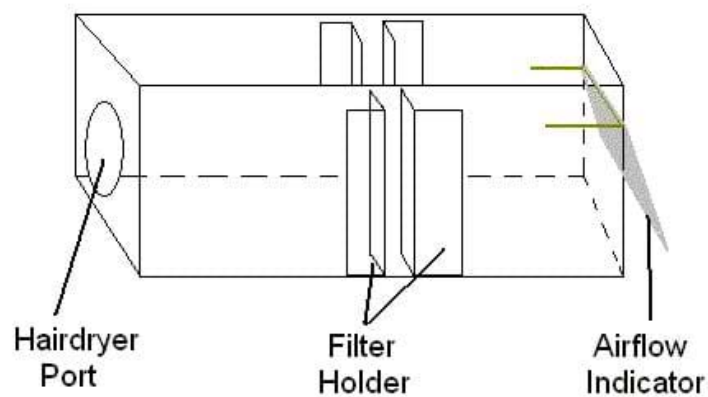


Figure 1. The filter testing apparatus.
copyright

1. Place sand on one side of the shoe box (closest to the opening where the hair dryer will be inserted).
2. Place the air filter in the holders.
3. Take half a sheet of graph paper and place glue from a glue stick onto the paper. Hold the glue paper up to the end of the shoe box where debris will come out.
4. Test each air filter twice by using a new graph paper with glue.
5. After two trials of testing, students will count 3 boxes on graph paper on each trial. Encourage students to count boxes from the top, middle, and bottom of the graph paper in order to gather accurate data.
6. Students will count particles in the 3 boxes on the graph paper and find the mean, median, and mode for each trial. If students struggle to see the sand particles, have them take a photo using their Macbook or iPad and zoom in.

https://www.teachengineering.org/activities/view/cub_enveng_lesson07_activity2

Testing Step 2:

- Students will record on the “Air Quality Testing Data” Google Doc
 - A photo of their final design
 - How they made their air filter
 - The mean, median, and mode of the results of their air filters

Mean will be used to calculate the average particles that travel through the air filter. Add the number of sand particles in the 3 boxes on the graph paper students used for testing. Example: 3 particles + 5 particles + 2 particle = 9 particles. Divided by 3 = 3 particles is the average particles for that trial of testing.

- At the bottom of the testing data document, students need to record questions or comments they would have for a person in New Delhi, India.

Testing Step 3:

- Students could watch the video on Canvas if they did not know how to calculate the mean, median, or mode.
 - https://www.youtube.com/watch?v=MoMxSK_kHZU

Lesson 6: Air Quality- Presenting and Reflecting

Time: 2.5 days (approximately 100 minutes)

- One day preparing to present
- One day presenting
- Half day reflecting

Step 1: Preparing to Present

- First presentation will be Google Slides. In future presentations, students can choose type of presentation.
- The presentation below is a template. One student in each group makes a copy of the template (link on Canvas) then shares it with group members.
 - <https://docs.google.com/presentation/d/1zR1bZr90HlgimlHxGBWcoULpuZVjJgkiLsn-C-t1RQo/copy>

Step 3: Reflecting

Group Reflections

STEP 1:

- Each group member will answer:
 - Did your project effectively solve the initial problem?
 - What were the pros of your project?
 - What were the cons of your project?
 - Did you personally give your best effort for this project?
 - What grade do you believe your group deserves based on the outcome of your project?
 - What were some new skills that you learned in this activity?
 - What would have made your project better or more successful?

STEP 2:

- Each person will roll a die to determine what answer they will share with their group.
 - Example: If you roll a 1, you will share the first question above with your group.

STEP3:

- The teacher will roll a die to determine what answer each group will share. Each group will likely share a different answer.