Teacher Activity Guide

Thank you for checking out the Bill & Melinda Gates Foundation Discovery Center's teacher resources! This activity asks students to test different masks. Student could complete the experiments in class or at home.

The purpose of this activity is to address the importance of following the directives of health experts for different contagions. At many times during the COVID-19 pandemic experts have recommended wearing face coverings to reduce the spread of the virus. We will examine the role of a mask and set up a mask experiment.

For this activity you will use the editable PowerPoint to share information, video links, and instructional videos for the various experiments. You may edit the PowerPoint to meet your classes needs prior to sharing it with your students.

**Brief Overview**
Through this activity guide students will test how the material and design of a mask can impact its use and ability to prevent the spread of aerosol droplets.

**Science Standards**
*NGSS Science and Engineering Practices:*
#1 — Asking questions and defining problems
#3 — Planning and carrying out investigations
#4 — Analyzing and interpreting data

**Goals:**
"Participants will..."
- Set up a mask experiment to address a stated hypothesis
- Gain an understanding of experimental design and how to share results
- Use critical thinking to connect their findings to real world situations

**Resources for Activity**
- Teacher Activity Guide and PowerPoint
- Student Worksheet
- *Optional follow up* — A Discovery Center Educator can join your class remotely for a follow up presentation and discussion on COVID, Data Literacy, or a number of other related topics.

**Introductory Discussion Questions**
Prior to the start of this activity you may choose to set aside time to discuss the current situation through some simple student questions that will help offer a real-world connection to their experiment's goals and purpose.
- Do you have a mask type or style you prefer?
- When do you feel a mask should be worn? What are some issues you have faced while wearing a mask?
- Does everyone have equal access to preventative/protective resources like masks?
- How does the quality and availability of resources impact one's risk or the risk to others in a community?

**Introductory Content**
The quality, material, and style of a face mask can greatly impact its efficacy at containing aerosol droplets. The comfort and style may also impact the wearers willingness to use the mask.
It is recommended that masks cover both the nose and mouth, that people avoid pulling mask down under their chin or around their neck, and that people avoid touching the front of their masks.

**Key Terms**

- **COVID-19**: the disease caused by the novel coronavirus
- **SARS-CoV-2**, the novel coronavirus – the virus which causes COVID-19
- **Droplet Spread Disease**: a disease mainly spread by large droplets of fluid, it cannot survive long in the air and is mostly spread by surfaces (in contrast to an airborne disease like measles, or blood born disease like Hepatitis B)
- **Aerosol disease**: a disease that can linger in small particles in the air

**Activity Outline**

*The PowerPoint has Teacher Guide Slides to facilitate your activity.*

**Introduction: Slides 3-9**
Start the activity with a short introduction of the situation and allow students a chance to share thoughts, ideas, and questions. If you do not know an answer to their question that is a great time to remind everyone this is still a very new situation and we are all learning. We should continue to look up current research and follow on-going studies by healthcare professionals and scientists. In fact, we are going to design an experiment of our own that may address some of the questions or thoughts expressed.

Possible discussion — For many of us, wearing a mask was not part of our “normal” but it is now. Knowing which mask to wear, when and how to wear it is important.

- **Questions** — *What do you think the role of a mask is? What factors impact your decision to wear or not wear a mask? What types of masks do you wear or prefer? What issues have you experienced with masks?*

**Optional Video(s): Slides 10-15 (select the videos that work for you)**
After the class has shared thoughts and questions you can watch one or more of the videos in the PowerPoint for more information. After the video(s) discuss what students learned.

- **VOX** — “What face masks actually do against coronavirus” (7.5 minutes)
  - https://www.youtube.com/watch?v=P27HRClMf2U
  - This video shows flow of air particles with and without a mask. It starts with global and national mask practices. The video goes on to discuss symptomatic and asymptomatic people and viral spread. The video also reviews hand washing and social distancing. Posted April 22, 2020

- **Centural Health** — “The Do’s and Don’ts of Wearing Masks and Gloves” (6 minutes)
  - https://www.youtube.com/watch?v=eVJbenwzR1s
  - Video shows how germs, bacteria, and viruses can spread through contact. Highlights proper Personal Protective Equipment (PPE) use and improper use. A nurse takes you step by step through proper hand and mask hygiene. Posted April 21, 2020

- **Bill Nye, TikTok** — “Movement of air through a mask.” (1 minute)
  - Video shows a simple experiment highlighting the movement of air from a person through different mask materials. Posted Spring 2020

- **CNN health** — “See how a mask affects how a cough travels” (3 minutes)
  - A lab at Florida Atlantic University is simulating a human cough to understand how far and fast cough droplets can spread. Posted May 4, 2020
• **The Sun - Florida Atlanta University** — “See how a mask affects how a cough travels” (1.2 minutes)
  - https://www.youtube.com/watch?v=cDE5J7og_xM
  - A lab simulation shows cough droplets can spread more than three and half meters.
    Posted May 6, 2020

**Experiment Setup Review: Slides 17-23**
Experiment set ups: Masks are not all created equal
• Review the basics of experimental design with students. You can then help them use one of the following experiment suggestions to test some of their favorite masks.

**Student Experiments: Slides 25-33 (Select one for your students or let them pick)**
Each experiment option will start with a PowerPoint slide showing the materials needed and a short instructional video and demonstration for that experiment.

Below you will find four suggested experiments for students based on their understanding of experimental set up, critical thinking, and ability to work independently. Details and short how-to videos are available on the PowerPoint for each suggestion below.

**Four Mask Experiments**
• **Droplet Spread**
  - Test different mask styles or materials.
  - Measure droplet spread by area impacted.
• **Airflow spread/force**
  - Test the impact of different masks on a candle flame. A non-fire option would be the movement of a folded piece of paper.
  - Measure the impact on a flame or the distance moved of a folded piece of paper on a flat surface.
• **Shifting of mask**
  - Test how a mask’s fit impacts its placement on the face and frequency of need to touch the mask.
  - Measure the distance a mask shifts on face during a yawn.
• **Mask impact on vision while wearing glasses**
  - Test different mask styles or fits and their impact on fogging glasses.
  - Measure the duration of condensation on glasses after exhale.

**Tips and Suggestions**

**Develop a Strategy/Design.** Once students know their topic it is time to develop their experiment. Depending on skill level and understanding of experimental design students may design their own experiment or use the template laid out below based on their question.

**Step 1: Establish the research question.** Once the experiment topic is selected from the list above the students should Identify their research question. Possible research questions are provided below.
• **Droplet Spread**
  - Does the mask material matter?
    - Students will test how different materials impact the droplet spray spread.
• **Airflow spread/force**
  - Does the mask material matter?
    - Students will test how different materials impact airflow.
• **Shifting of mask**
  - Does fit matter?
    - Students will test the fit of a mask over time and how much it shifts.
    - Examples:
      - Wearing different masks as they complete an action- yawn, talk, laugh- and measuring how much the mask has shifted on the face. This could include testing tie behind versus ear loop or pleats versus no pleats.
• Mask impact on vision while wearing glasses
  ◦ Does the type of mask impact fogging of glasses?
    ◦ Students test impact of masks on fogging glasses.
    ◦ Example:
      - Wearing different masks along with glasses (sun or vision) as they exhale or talk, measure the duration of lens condensation.

**Step 1 continued: Establish the variables**

• What is the control?
  ◦ Droplet Spread — No Mask
  ◦ Airflow spread/force — No Mask
  ◦ Shifting of mask — Student’s preferred/regular mask
  ◦ Mask impact on vision while wearing glasses — Student’s preferred/regular mask or no mask.

• What is the independent variable? What is the cause/what changes.
  ◦ Droplet Spread — type of mask used
  ◦ Airflow spread/force — type of mask used
  ◦ Shifting of mask — style of mask worn
  ◦ Mask impact on vision while wearing glasses — style of mask worn

• What is the dependent variable? What is the effect.
  ◦ Droplet Spread — droplet spread
  ◦ Airflow spread/force — airflow impact
  ◦ Shifting of mask — distance of mask shift
  ◦ Mask impact on vision while wearing glasses — duration of fogging

**Step 2: Write your hypothesis.** Pick a specific, quantifiable, testable statement that addresses your research question.

• Possible hypotheses:
  ◦ Droplet Spread — If a mask is used in front of the source of droplet spray, then the spray impact of the area around the source will be reduced.
  ◦ Airflow spread/force — If a tightly woven mask is used in front of the source of airflow, then the flow of air from the source into the area around the source will be reduced.
  ◦ Shifting of mask — If a mask does not fit properly, then it will shift during common face movements.
  ◦ Mask impact on vision while wearing glasses — If a mask has a fitted wire over the nose, then it will reduce the impact of condensation on glasses.

**Step 3: Design the Experiment.** Establish how you will manipulate the independent variable and establish how many trials you will conduct. Keep in mind, reliable repetition of the experiment is important.

• Tips:
  ◦ Conduct at least 5 trials for the control and each independent variable tested. Record your experiment setup as accurately and with as much detail as possible.
  ◦ Reduce all possible external impacts such as wind, room temperature, and human error.
  ◦ Do not let your expectations bias the experiment.

Write your experiment plan, include a list of materials and any exact details someone would need to replicate your experiment. This is known as the methods section in a scientific report.

**Step 4: Record your results.** Record the results of each trial conducted. Once all trials are complete summarize the results. This information will influence your experiment discussion and recommendations.

• Tips:
  ◦ Record results as soon as each individual trial is done.
  ◦ Do not infer or extrapolate your results, record only exactly what happened.
  ◦ Do not let your expectations bias how you record the results.
Step 5: Discussion of results. After you have your results it is time to share your findings. Offer suggestions on what to study next, infer how your results might impact future actions.

- Optional discussion points:
  - What do the results tell you? What did you discover?
  - Did the results support your hypothesis?
  - Is there any error that needs to be discussed?
    - Human error is common and often not 100% preventable.
  - Were there any trends or correlations?
  - Were any findings inconclusive?
  - What would you test next?

Activity Wrap-up

After students have conducted their experiments and shared their results you can address any trends or reoccurring themes or questions. This is also a good time to revisit the questions from your initial discussion to see if anyone wants to add connections or to discuss possible changes in opinion.

The Gates Foundation Discovery Center offers remote learning workshops that explore the science behind COVID-19, Social Justice issues, Data Literacy, and so much more. We hope you take advantage of these opportunities this school year.