Snot Science educator guide

By *Science News for Students*

This is the time of year when everyone seems to be sneezing. What do you do to stay healthy? “Snot Science” examines a sneeze as only scientists can — by modeling sneezes in the lab to answer an age-old question: How far does a sneeze really travel? Join our resident scientist, Bethany Brookshire, on her exploration. Then use her ideas to formulate your own experiment!

Connections to Curricula:

- Preventing disease transmission
- Designing an experiment
- Testing variables
- Analyzing data
- Formulating results

Standards Alignment

Next Generation Science	Common Core
Ecosystems: Interactions, Energy, and Dynamics: MS-LS2-2, HS-LS2-2	ELA Standards: Reading Informational Text (RI): 7
Engineering Design: HS-ETS1-2	ELA Standards: Speaking and Listening (SL): 4
	ELA Standards: Reading for Literacy in Science and Technical Subjects (RST): 2, 3, 4, 7, 8, 9
	ELA Standards: Writing Literacy in History/Social Studies and Science and Technical Subjects (WHST): 2, 6
	Math Standards: Statistics and Probability: 6.SP.5, 7.SP.4, 8.SP.1

Links for the DIY Science video series “Snot Science”

DIY Science VIDEO: http://bit.ly/SnotScienceVideo

Blog #1, “Snot Science: A snotty setup”: http://bit.ly/SnotScience1

Blog #2, “Snot Science: Results are nothing to sneeze at”: http://bit.ly/SnotScience2

Blog #3, “Snot science: Taking mucus to the next level”: http://bit.ly/SnotScience3

How to use this *Science News for Students* series

The video and blog posts can be used together whether teaching about communicable diseases or experimental design. The following sequence is designed to help you highlight opportunities that these resources provide. Use those that fit best in your larger instructional plan.

Introduce the experience:

1. Get a sense of what your students already know. Ask what they know about ways diseases can be spread and how often they've stood near someone who sneezed. What do they think might happen as a result of their proximity? [*Students will likely say they might catch that person's germs.*]
2. When they think about sneezing, what types of questions come to mind? [*Students might say things like: Will I get sick? How far does that snot travel? How far do I have to be from others to be safe?]*
3. Tell students that scientists take beliefs — such as "standing near someone who's sick will increase the chance that you will get sick" — and test them out. They do this by breaking the idea into smaller pieces, each of which can be tested. Ask students to brainstorm all the ideas that can be tested related to being near someone who sneezes. Chart the students' responses.

Watch the experiment:

4. **Show the DIY Science video**. Depending on your students' background, you might want them to have a reference for the vocabulary used in the video [Blackline Master 1]. Students can define the words before watching and add ideas while they watch.
5. Provide students with the set of comprehension questions [Blackline Master 2] to help them capture the main ideas from the video.

Replicate the experiment:

6. Tell students that they've been asked to repeat Bethany's experiment. Put them in groups of 3 to 4. Give them **Blog #1, "Snot Science: A snotty setup,"** to help them create a clear set of procedures for Bethany's experiment. You might also give them a template [Blackline Master 3] to help them write out their procedures.
7. Have a group share the procedures; have others check to see if anything is missing. Be sure students have a clear set of materials that matches the procedures.
8. To have students implement Bethany's experiment, here are a few options:
    a. Option 1 (*most time consuming*): Have all the groups do the full experiment.
    b. Option 2 (*a bit less time consuming*): Have some groups test thin snot and some test thick snot.
    c. Option 3 (*least time consuming*): Have 2 or more groups do thin snot and 2 or more groups do thick snot and have them compare their data.

Analyze the data:

9. To determine the number of trials needed to form a statistical inference, scientists use principles of probability. Depending on students' math background, you might want to walk students through Table 2 from Jacob Cohen's Power Primer (http://www.bwgriffin.com/workshop/Sampling%20A%20Cohen%20tables.pdf). Give students **Blog #2, "Snot Science: Results are nothing to sneeze at,"** so they can see how Bethany set up her data table. Point out that the thin snot was tested 26 times. So was the thick snot, for a total of 52 trials, not 26. Ask why? [*Each variable needs to be tested the number of repetitions from Cohen's Table 2.*]
10. Have students read through how Bethany analyzed her data. Students can use a template [Blackline Master 4] to replicate Bethany's process and then repeat it using their own data.
11. Discuss each group's data. In what ways are they similar to and different from Bethany's? What might account for the differences?
12. Give students **Blog #3, "Snot science: Taking mucus to the next level."** Have them read about the other snot studies. Discuss how Bethany's experimental results differed from other scientists' data. Discuss how your class' data add to this conversation.
13. Have students read through the limitations that Bethany described. Do they agree with this list? Are there any ideas they would add? By replicating Bethany's experiment, what have students learned?
14. At the end of Bethany's article, she invites people to let her know about their experience replicating the experiment. Students can take her up on the invitation. Challenge them to create a message that Bethany would respond to!

Moving beyond:

15. What other ideas could students test? A few ideas are presented in Blog #3. Have students revisit and add to their brainstorming of questions that could be answered. Encourage students to create an experimental design.
16. Students can share what it is they want to test and how they'd design their experiment.
17. If time allows, students can implement these original designs in class, or on their own.

Related stories in *Science News for Students*

Explainer: What is a virus?
https://www.sciencenewsforstudents.org/article/explainer-what-virus

Cold noses nurture colds
https://www.sciencenewsforstudents.org/article/cold-noses-nurture-colds

Flu in the air
https://www.sciencenewsforstudents.org/article/flu-air

New ways to fight the flu
https://www.sciencenewsforstudents.org/article/new-ways-fight-flu

Deadly new flu
https://www.sciencenewsforstudents.org/article/deadly-new-flu

Even penguins get the flu
https://www.sciencenewsforstudents.org/article/even-penguins-get-flu

Cookie Science: Bake your way to your next science project!
https://www.sciencenewsforstudents.org/collections/cookie-science

When a study can’t be replicated
https://www.sciencenewsforstudents.org/article/when-study-can%E2%80%99t-be-replicated

Blackline Master 1: Vocabulary

Directions: Below are some words used in the video you may not be familiar with. Take a look and write down what you think they mean, then confirm your thinking when you watch the video.

Word	What I think it means	What it means in this context
Viscosity		
Hypothesis		
Variable		
Control		
Model		
Gelatin		
Histogram		
Power analysis		

Vocabulary answer key:

- **Viscosity:** A measure of how thick a fluid is; a fluid's resistance to flow
- **Hypothesis:** A prediction or statement that can be tested
- **Variable:** Something that can change in an experiment
- **Control:** Something that is not changed during an experiment
- **Model:** A representation of something that happens in the real world
- **Gelatin:** A thickening substance used in many foods, such as Jello
- **Histogram:** A type a graph used to show how data is spread out over a range
- **Power analysis:** A system that tells a scientist how many times an experiment needs to be repeated in order to generalize the results

Blackline Master 2: Comprehension Questions

Directions: Use these questions to track the main ideas from the video and blog posts:

1. What causes a cold or flu?

2. What is the “flu vaccine” and what are the benefits of taking it?

3. How do viruses and bacteria spread?

4. What is being tested in the video?

5. What does Bethany use to represent the nose?

6. Describe the set up for the snot experiment.

7. Why is the combo of corn syrup and gelatin a good model for snot?

8. Why was food coloring used in the thin snot?

9. Why do scientists repeat their experiments? How do they know they’ve done enough trials?

10. What types of tests are used to analyze the results of the experiment?

11. What did other studies find out about sneeze distance, and how their findings compare to those in this experiment?

Comprehension Questions answer key

1. What causes a cold or flu? [*viruses*]
2. What is the "flu vaccine" and what are the benefits of taking it? [*The vaccine helps your body create antibodies to protect you against infection from specific viruses. Once your body has these antibodies, it can fight a real infection more quickly*.] source: http://www.cdc.gov/flu/protect/keyfacts.htm
3. How do viruses and bacteria spread? [*by air, touch, ingestion and bodily fluids*]
4. What is being tested in the video? [*how far does thin and thick snot travel*]
5. What does Bethany use to represent the nose? [*a pipette*]
6. Describe the set up for the snot experiment.
7. Why is the combo of corn syrup and gelatin a good model for snot? [*Natural snot is made from water, sugars and proteins. Corn syrup and gelatin are made from the same constituents.*]
8. Why was food coloring used in the thin snot? [*The food coloring helps the simulated snot stand out against the white background of the landing zone*.]
9. Why do scientists repeat their experiments? How do they know they've done enough trials? [*The more times an experiment is repeated, the more reliable the results. They can eliminate type 1 and 2 errors. Scientists use tools, such as a power analysis, to determine the number of trials they need to perform.*]
10. What types of tests are used to analyze the results of the experiment? [*mean and t-test*]
11. What did other studies find out about sneeze distance, and how their findings compare to those in this experiment? [*Other* studies said *snot can travel 2 to 8 meters. This experiment didn't get the same distances, but it did find that thick snot travels a shorter distance than thin snot.*]

Blackline Master 3: Experimental Design

Directions: Use the space below to recreate the steps from Bethany's experiment

Purpose of your experiment:

Hypothesis:

Materials:

Procedures:

1.

2.

3.

4.

5.

6.

7.

8.

Data collection table:

	Thin snot	Thick snot
Sample	**Max distance (cm)**	**Max distance (cm)**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
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26		

Notes:
Here is a good place to keep track of observations, unexpected challenges, or thoughts that come to mind when doing the experiment.

Blackline Master 4: Analyzing Data

Directions: Use Blog #2 to follow Bethany's process for analyzing data. You can use her process to teach yourself what to do. Then, repeat the process using your data.

	Bethany's Data		*My Data*	
Mean (s):	**Thin snot**	**Thick snot**	**Thin snot**	**Thick snot**
T-test: p-value (if >0.05, the results are statistically significant)				
Standard deviation (s)				
Sample size (n)				
Effect size (Cohen's d value): >0.2 is small effect 0.5 is medium effect 0.8 or above is large effect				

Revisit your data. How are they concentrated? Organize your data by number of drops per 50 centimeters of tarp. Create a chart like this one that includes enough columns to record all of your data. Make one for thin snot and one for thick snot:

Thin snot	**Droplet spread (per 50 cm)**			
Sample	0-50	51-100	101-150	151-200 …
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				

Thick snot	Droplet spread (per 50 cm)			
Sample	0-50	51-100	101-150	151-200 …
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
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25				
26				

Create a histogram for your data. There are many online help tools for doing this in Excel. Otherwise, you can build one by hand: