



# Science Can Make You Strong

## Lesson Set 5 of 5



**NCSE**  
National Center for  
Science Education

## Teacher Prep

**Age Levels:** 9th - 12th grade

**Time Commitment:** 4-6 days  
(if all activities completed)

### Key Vocabulary/Concepts:

- *COVID-19 theme:*  
pseudoscience, Karl Popper, [Barnum effect](#) (Forer effect), mortality risk, hazards, viruses, pathogens, the spread of disease, aerosols, droplets, vectors, social distancing, risk assessment, germ theory

### Materials:

- [Lesson Set Five Teacher Resources](#)

*Note: All activities, readings, and worksheets are located in this folder*

- Internet access
- Pairs of dice (1 pair/3 students)
- Approved lab equipment for experimentation
- Variety of face masks/materials

### Apps and Software:

- [Google Jamboard](#)
- [Kahoot](#) access
- [YouTube](#) access
- [EdPuzzle](#) access

## Introduction

**This lesson's primary goal is to help meet one of the most essential challenges in middle and high school science: How do you help students distinguish between sound science and unintentional misinformation or even blatant pseudoscience?**

This lesson applies information and insights gained from the first four Nature of Science COVID-19 storylines to investigate an important current topic—the effectiveness of masks. As new discoveries emerge, this lesson will continue to be updated for relevance.

## Teacher Goals

- 1) Provide students with clear examples of pseudoscience or conspiracy theories tied to pseudoscience to help them detect and cope with them (as adults/in their daily lives)
- 2) Explain why being a healthy skeptic is so crucial to the process of science
- 3) Emphasize that science is self-correcting by nature—unsound science cannot survive under the scrutiny of the scientific community

## Student Learning Goals

- 1) Examine a claim and use credible, empirical evidence to determine whether the claim is credible science or misinformation
- 2) Recognize the importance of being a healthy skeptic (not cynic!) and critical thinker when presented with unfamiliar concepts or ideas
- 3) Distinguish between science and non-science, including pseudoscience
- 4) Understand that accepted scientific ideas are subject to change, but only in light of credible evidence or theory

## Nature of Science Lesson Set Series

<https://ncse.ngo/supporting-teachers/classroom-resources>



NATURE OF SCIENCE

[Lesson Set 1: Science is a Way of Knowing](#)

[Lesson Set 2: Science is a Never-Ending Process](#)

[Lesson Set 3: Science is an Inquiry-Based Process](#)

[Lesson Set 4: Science is About the Evidence](#)

[Lesson Set 5: Science Can Make You Strong](#)



## Background



### Teacher Knowledge

#### Nature of Science

One of the most important concepts students will need to navigate as adults is identifying **pseudoscience** when they encounter it online. While it is hard to quantify the level of misinformation students are exposed to, the proliferation of information sources and the deliberate promulgation of misinformation have increased in the past ten years, especially with each political cycle.

As teachers, it is imperative to help our students navigate this increasingly chaotic information environment. Therefore, be sure to review several examples of pseudoscience for yourself before working with students. Be sure you are clear on what is and isn't considered sound, peer-reviewed science. Consider reading through "[What is Pseudoscience?](#)" For even more information, follow up by reading the entry in the [Stanford Encyclopedia of Philosophy](#), which discusses a variety of attempts to provide a rigorous definition of pseudoscience. Texas Tech University also has an excellent library of resources on [Fake News, Misinformation, and Pseudoscience](#) to increase your background on the subject.

#### Scientific Concepts:

This lesson uses epidemiology as the basis for its major storyline. Major concepts that will be discussed to some degree include viruses, public health, pathogens, disease spread, aerosols, droplets, vectors, vaccines, vaccinations, social distancing, risk assessment, and germ theory.



### Discussion Points

- How do we distinguish between science and pseudoscience?
- How do scientists determine risk? Is luck a social construct?
- What is the effectiveness of different types of masks?
- Why is the government involved in public health anyway?



## Core Misconceptions

**✗ MISCONCEPTION:** *Science can't be trusted; scientists are constantly changing their minds.*

**✓ FACT:** It is essential to be a healthy skeptic (not cynic!) and critical thinker when presented with new information.

**✓ FACT:** Not everything that is presented as science is sound science, so it's important to be able to recognize unsound science and pseudoscience.

**✓ FACT:** Even the most widely-accepted and best-supported scientific ideas are subject to change if warranted by new evidence.

**✗ MISCONCEPTION:** *Science and technology (applied science) can solve all of our problems.*

**✓ FACT:** Science is one tool that helps us understand the world, and technology helps us apply that science to solve some of our problems, but it cannot solve every problem encountered.

**✗ MISCONCEPTION:** *If something is scientific, it is always reliable and accurate.*

**✓ FACT:** Not all scientific information comes from unbiased sources, and all scientists are humans who can lack objectivity.

**✓ FACT:** Evaluation of a scientist's credibility is an integral part of the critical-thinking process.

**✓ FACT:** Over time, science is self-correcting—biased research cannot be replicated and will eventually be rejected by the broader scientific community.



## Prerequisite Student Knowledge

Before beginning Lesson Set Five, if following the COVID-19 theme, the amount of background knowledge your students need will directly correlate to how many of the previous nature of science lessons they completed throughout the year. If this is their introduction to epidemiology, consider reviewing some of the materials found in [previous lesson sets](#) before completing this lesson set. Alternatively, have students investigate the [timeline of COVID-19 developments](#) before this lesson set.



## Teacher Instructions



### Anchoring Phenomenon: [Investigating Pseudosciences](#)

#### Activity 1: Confirmation Bias in Action: Horoscopes

- Follow the directions provided in *Horoscopes and Confirmation Bias\_Teacher Instructions*
- **Important Note:** The student handout is meant to be deceptive, which is a part of the activity's ultimate purpose
- **Extension Activity:** For a more in-depth experience, consider Larry Flammer's "How's Your Horoscope?" located in the Deeper Dive section of this document

#### Activity 2: The Misconception of Chance—Feeling Lucky?

- Have students examine the difference between the concept of luck and fractional probability by charting the results of a simple dice game
- All gameplay directions can be found in the document titled *Lucky Number Seven?!\_Student Handout*
- Class results should be recorded using the Lucky Number Seven\_Class Data Spreadsheet
- A possible variation of this activity could be playing [Left, Center, Right, Tenzies](#), or any dice/card playing game and have students calculate probabilities to win.
- **Important Note:** The goal of the activity is to show students that there is no such thing as the concept of luck—simply probability and statistics at their finest.

#### Activity 3: What is Pseudoscience Anyway?

- Make a copy of the What is Pseudoscience Anyway? Google Jamboard
- As an introduction to the term "pseudoscience," watch the Crash Course Video: [Karl Popper, Science, & Pseudoscience: CC Philosophy #8](#) (8:56)
  - Consider generating a Kahoot, EdPuzzle, or Google Jamboard organizer about this video to check for understanding and to help generate discussion
- Using the Jamboard, have the class develop a general explanation of pseudoscience.
- On the next slide titled Driving Questions Board, have students generate questions they have about pseudoscience
- On the final Jamboard slide, have students list as many examples as possible of instances where pseudoscience has (or might have) infiltrated our understanding of the spread of COVID-19 and wearing face masks.
- Explain to students that we will be focusing on debunking misconceptions about personal protective equipment, especially face masks or shields.
- Emphasize that recognizing pseudoscience in social and news media is a life skill that students need to develop beyond this activity. Both astrology and luck are easily debunked using the scientific process and Claim-Evidence-Reasoning (C-E-R) strategies, but many examples of pseudoscience can be much more deceptive and hard to identify when encountered. Developing a healthy skepticism is imperative to becoming a well-rounded 21st-century citizen.



## Storyline Activities

### Part A: Identifying Hazards vs. Risks

- Assign *That Daily Shower Can be a Killer* reading by Jared Diamond
- Conduct a class discussion:
  - *What do you think is the greatest hazard you are likely to encounter in your area? Is it an activity that you see as the most personal risk to yourself, to others or to an area?*
  - *Thinking of Diamond's example of New Guineans not sleeping under dead trees, what is at least one thing we do as a society to reduce risk to the hazard you listed above?*
- Idea: Group students for a Think-Pair-Share to discuss the above prompts before polling the whole class
- After discussion as a whole class, hand out the next activity, *Hazard or Risk?* Explain that we will now be looking at how bias influences our perception of risk
- Have students study the cartoon and respond to the questions. Engage is a class discussion about the hazards and risks the parachutist encounters.
- This activity was adapted from a small portion of [InTeGrate Natural Hazards and Risks: Hurricanes](#) unit

### Part B: What, Me Worry?

- Students will examine their own personal biases when assessing risk by analyzing several pieces of data
- **Activity 1:** Decision-making. Follow the directions on *Decision-making\_Teacher Instructions*
- **Activity 2:** Risk Assessment. Follow the directions on *Risk Assessment\_Teacher Instructions*.
- These activities were modified from the work of Andrew Petto of the University of Wisconsin-Milwaukee and are used with his permission.

### Part C: COVID-19 Risk Calculators

- Students will analyze a variety of “risk calculators” available online that identify potential risks associated with certain activities and behaviors
- **COVID-19 Data:** Using Our World in Data's [Mortality Risk of COVID-19](#), students can compare the case fatality rate of various countries. Ask students to examine how America's risk measures up to other countries at different points in time (the data is updated daily). Students may also be interested in examining the related chart “Total confirmed deaths and cases [time-series]”.
- **Risk Calculator 1:** [19 and Me: COVID-19 Risk Score Calculator](#). This tool aggregates reported COVID-19 geographic case data. Students enter information about themselves and their behavior to receive a risk score from 0-100. *Note: Data entered into the risk calculator is not collected or stored - see FAQ tab for more information.*
- **Risk Calculator 2:** [COVID Can I Do It?](#) Students will select an activity and state. The calculator will give the activity a 1-5 risk rating along with information about how the activity ranks for crowding, droplet spread, time, and ventilation.



## Storyline Activities (continued)

### Part C: COVID-19 Risk Calculators (continued)

- **Risk Calculator 3:** [COVID-19 Event Risk Tool](#). Students are able to view a US map to ascertain the risk level of participating in events of various sizes.
- A series of risk assessment infographics have also been included if you'd prefer students not to enter information online
- Group Discussion: After completing this activity, hold an in-class discussion about the strengths and weaknesses of risk calculators
  - Be sure to assess what questions students have about the legitimacy of these online resources (organization hosting calculator, differences seen across platforms, frequency of updates, etc.)
- Culminating Questions:
  - *What themes of safety and precaution were seen across all the various platforms investigated?*
  - *Were masks and social distancing emphasized by each site?*

### Part D: [To Wear or Not To Wear](#)

- Preview the activity by reading through *To Wear or Not to Wear\_Teacher Instructions*
- Begin this activity by watching the video: [Nothing to Sneeze At](#) (5:03) about how scientists at MIT used high-speed cameras and fluid mechanics to understand how droplets containing pathogens can spread. Questions to discuss:
  - *How might the droplets spread by sneezes be prevented from reaching other people?*
  - *How is understanding the anatomy of a sneeze related to the spread of COVID-19?*
- Next, refer to the Jamboard slide from Anchor Activity 3: What is Pseudoscience Anyway? containing the various claims students have heard made about masks/face shields/other protective coverings during the pandemic
  - Have students narrow down the list to claims that can actually be tested or studied through research
  - Consider having students use the resources from the Lesson Set 1 Part D: [Examining Reliable Resources](#) if they have not previously used it when selecting their claims
- Explain to students that they will be taking their claims about masks to “court”. Students will need the following handouts:
  - *Science Claims Court Research Guide*
  - *Science Claims Court Discovery and Investigation*
  - *Science Claims Court Juror Notes*
- Allow students to work in small groups or individually depending on the current learning environment and restrictions
- Students should develop an experimental protocol to test one of the claims selected for investigation by the class, conduct the tests (either in-class or at home), then present their evidence to the “jury”



## Storyline Activities (continued)

### Part D: To Wear or Not To Wear (continued)

- Culminating Questions:
  - *What does the research show about wearing masks to prevent contracting COVID-19?*
  - *Are some forms of mask protection better than others? Why or why not?*
  - *What other products on the market could we safely test that claim to protect against COVID-19?*
  - *After having completed this activity, are you more likely to wear masks outside of your own home? Why or why not?*
  - *Do you feel more confident in your ability to identify authentic scientific research vs. unsubstantiated social media claims? Why or why not?*
- Conclude this activity, by having students read the article “What the Data Say About Wearing Face Masks” from the journal *Nature*
  - Consider using a reading strategy for this assignment, as it contains a great deal of information that can help them during the claims court activity
- This activity was [adapted](#) from Laura Candler’s Green Claims Court with her permission.s



## Extension Activities

### Deeper Dive

- Larry Flammer Horoscope Debunking Activity: [How’s Your Horoscope?](#)



## Online Resources

- » [YouTube Crash Course Video: Karl Popper, Science, & Pseudoscience: CC Philosophy #8 \(8:56\)](#)
- » [Our World in Data’s Mortality Risk of COVID-19](#)
- » [Mathematica’s 19 and Me: COVID-19 Risk Score Calculator](#)
- » [COVID: Can I Do It? Risk Calculator](#)
- » [Georgia Institute of Technology’s COVID-19 Event Risk Assessment Planning Tool](#)
- » [YouTube video: Nothing to Sneeze At \(5:03\)](#)



## Primary Literature/Works Cited (continued)

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