Science can make you strong
Lesson 5 of 5

Teacher Prep

Age Levels: 6th - 12th grade
Note: MS modifications referenced in Student Directions if needed

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
- Ecology theme: pseudoscience, Karl Popper, Barnum effect (Forer effect), eco-friendly, vegan, recycled, plant-based, climate-friendly, carbon footprint

Materials:
- Lesson Five Teacher Resources folder
  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 (COVID-19 theme)
- “Eco-friendly” products (Ecology Theme)

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. For teachers who did not have students work through the previous COVID-19 storylines, an alternative current event is provided to help debunk the same kinds of misconceptions.

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

Nature of Science Lesson Plan Series
https://ncse.ngo/supporting-teachers/classroom-resources
Lesson 1: Science is a Way of Knowing
Lesson 2: Science is a Never-Ending Process
Lesson 3: Science is an Inquiry-Based Process
Lesson 4: Science is About the Evidence
Lesson 5: Science Can Make You Strong
Lesson Five: Science can make you strong
(Lesson 5 of 5)

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 or via social media. 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 has increased in the past ten years, especially with each political cycle (see Original Activities and Documents).

It is imperative to help your 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?” Then 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 pseudoscience and other propaganda forms to increase your background on the subject.

Scientific Concepts:

This lesson uses epidemiology as the basis for its major storyline; however, alternatives are also presented should teachers choose to avoid COVID-19 topics in the classroom. 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. If pursuing the ecology version of the activity, be sure to have an understanding of product monikers like “vegan,” “plant-based,” “climate-friendly,” “eco-friendly,” “recycled,” and “alternative therapies.”
Lesson Five: Science can make you strong
(Lesson 5 of 5)

Discussion Points

a) How do we distinguish between science and pseudoscience?
b) How do scientists determine risk? Is luck a social construct?
c) What is the effectiveness of different types of masks?
d) Why is the government involved in public health anyway?
e) What products are genuinely eco-friendly to the environment?

Note: Whether to use discussion point (e) depends on which lesson plan path the teacher follows

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 our problems.

✓ 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.
Lesson Five: Science can make you strong
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Prerequisite Student Knowledge

Before beginning Lesson 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 lessons before completing this activity. Alternatively, have students investigate the timeline of COVID-19 developments before this lesson. If completing the substitute storyline, students will need a basic understanding of the environment, climate change, and humans’ roles and responsibilities in protecting the planet.

Choose Your Own Adventure Student Directions

Intro Anchoring Phenomenon for BOTH Adventures

YouTube Crash Course Video: Karl Popper, Science, & Pseudoscience: Crash Course Philosophy #8

- For this lesson, a general explanation of pseudoscience is needed before conducting the anchoring activities that follow
- Consider generating a Kahoot, EdPuzzle, or Google Jamboard organizer about this video to check for understanding and to help generate discussion

Confirmation Bias in Action: Horoscopes

- Follow the directions provided in the teacher handout titled Horoscopes and Confirmation Bias
- Provide students with copies of the worksheet titled What’s Your Sign?—The Art of Astrological Science
- Important Note: The student worksheet 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

The Misconception of Chance—Feeling Lucky?

- Middle School Version:
  - 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 worksheet titled Feeling Lucky—Are Some People Luckier than Others?
  - Class results should be recorded using the spreadsheet provided in the Teacher Resources folder
  - A possible variation of this activity could be playing Left, Center, Right and having students calculate probabilities of the rolls required to win the “pot”
Lesson Five: Science can make you strong
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Intro Anchoring Phenomenon for BOTH Adventures (continued)

The Misconception of Chance—Feeling Lucky? (continued)

• High School Version:
  - Have students examine the difference between the gambler's fallacy and fractional probability by charting the results of a popular game of chance—craps
  - All gameplay directions can be found in the worksheet titled Feeling Lucky—Does the House Always Win?
  - Individual and class results should be recorded using the spreadsheets provided in the Teacher Resources folder
  - Background on how to playing craps can be found here if needed:
    · YouTube Video: Basic Rules of Craps
    · Website: How Craps Works
    · Website: Craps Rules
  - Important Note: Some schools may frown upon teaching students a game used in gambling. However, the point 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. Regardless, be sure to discuss using this activity with your building administrators before implementing it. In an effort to keep the focus on the concepts only, students will be betting “credits,” not money. High school students can use the middle school version of this activity if your administration has concerns.

Pseudoscience Google Jamboard Discussion/Q&A

• At this point, it is crucial to bridge the introductory activities completed to the upcoming “choose your own adventure” storylines
• Make a copy of the Google Jamboard found in the Teacher Resources folder with the appropriate label: “COVID-19” or “Eco-friendly”
• Encourage students to list as many examples as possible of instances where pseudoscience has (or might have) infiltrated our understanding of the current pandemic or humankind’s impact on the environment
• Explain to students that we will be focusing on debunking misconceptions about personal protective equipment, especially face masks or shields. If pursuing other storylines, we will be focusing more on products that make over-zealous claims about being environmentally friendly or sustainable
• 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 knowledgeable 21st-century citizen.
Choose Your Own Adventure Student Directions

COVID-19 Safety and Prevention Theme

Identifying Hazards vs. Risks

• Assign “That Daily Shower Can be a Killer” reading
  1) This essay by Jared Diamond can be assigned as homework or read together in-class
  2) A hardcopy can be found in the Teacher Resources folder
• During class discussion, have students answer the following prompts:
  1) 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?
  2) 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?
• Group students for a Think-Pair-Share to discuss these prompts before polling the whole class
• After discussion as a whole class, hand out the next activity, Identifying Hazards vs. Risks, while explaining that we will now be looking at how bias influences our perception of risk
• This activity was adapted from a small portion of InTeGrate Natural Hazards and Risks: Hurricanes unit

Risk Assessment Activity: What, Me Worry?

• Students will examine their own personal biases when assessing risk by analyzing several pieces of data
• Follow the directions provided in the teacher handout titled What, Me Worry? Decision Making and the Assessment of Risk
• This activity was modified from the work of Andrew Petto of the University of Wisconsin-Milwaukee and is used with his permission. See the Original Activities and Documents folder for his original document

Activities and Handouts

COVID-19 Risk Calculators

• Students will analyze a variety of “risk calculators” available online that identify potential risks associated with certain activities and behaviors
• First, using Our World in Data’s Mortality Risk of COVID-19, students can compare how America’s risk measures up to other countries (the data is updated daily)
• Then, students will input their age, sex, state, etc. into the various calculators to evaluate a certain activity and the “risk” associated with that activity
• A series of risk assessment infographics have also been included if you’d prefer students not enter information online
Activities and Handouts (continued)

COVID-19 Risk Calculators (continued)

- **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 Question:** What themes of safety and precaution were seen across all the various platforms investigated? Were masks and social distancing emphasized by each site?
- Students will follow the directions provided in the worksheet entitled *Acceptable Risks and COVID-19*

To Wear or Not To Wear

- Prior to this activity, students need to read the *Nature* article entitled "What the Data Say About Wearing Face Masks"
  - A pdf version of the article can be found in the Teacher Resources folder
  - 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
- Next, brainstorm (or make a Google Jamboard of) various claims students have heard made about masks/face shields/other protective coverings during the pandemic
  - During class discussion, help 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 One activity titled *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”
- 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 research and evidence to the “jury”
- **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?
- This activity was adapted from Laura Candler’s Green Claims Court with her permission. See the Original Activities and Documents folder for her original document
Choose Your Own Adventure Student Directions

Ecology Theme

Anchoring Phenomenon

“What is Greenwashing? How to Spot It and Stop It” reading

- This article by Leyla Acaroglu can be assigned as homework or read together in-class
  - A pdf version of this article is available in the Teacher Resources folder
- During class discussion, have students answer the following prompts:
  1) What are some examples of possible greenwashing you have encountered in advertising?
  2) What is sustainability and in what ways could companies work towards it?
- Group students for a Think-Pair-Share to discuss these prompts before polling the whole class
- After discussion as a whole class, hand out the next activity: The Deadly Sins of Greenwashing

The Deadly Sins of Greenwashing

- Students will read the article titled “The Six Sins of Greenwashing” as well as study the infographic provided in the Teacher Resources folder
- Using these sources, they will study greenwashing examples and identify which “deadly sin” was committed by the advertisers presented
- Finally, students will pick an everyday item or object they have in their home to “greenwash” by either making a video or digital advertisement
- This activity was adapted from an activity by Krista Bittenbender Royal of the University of South Florida. See the Original Activites and Documents folder for her original work

Activities and Handouts

Green Claims Court

- Students take eco-friendly (or green) products to “court”
- Students select a claim made by an advertiser about their product that marks it as eco-friendly in some way (e.g., 100% biodegradable, 75% plant-based, 100% recyclable)
- Then they research the validity of these claims using the worksheet provided titled Green Claims Court as a guide
- Students can work individually or in small groups depending on the constraints of their current learning environment
Activities and Handouts (continued)

Green Claims Court (continued)

- Students will return to court to present their research to the jury, indicating whether the advertiser committed greenwashing
- If there’s time, consider a call-to-action piece where students write a letter to the advertiser either congratulating them on their victory in “court” or encouraging them to update their industrial practices to match their unsubstantiated claims
- Culminating Questions:
  - What did you learn about marketing by completing this activity?
  - In what ways do you feel more confident that you can identify sound scientific research from the frequent hype that accompanies advertising?
  - Why is it so critical for manufacturers to update their business practices and industrial policies to match their advertising?
- This activity was adapted from Laura Candler’s Green Claims Court with her permission. See the Original Activities and Documents folder for her original document

Alternative Therapies/Performance Enhancements Claims Court

- A third storyline to consider for claims court has more of a physiological slant: students could investigate homeopathic remedies, performance enhancement products for athletes, or other forms of holistic or alternative medicine
- Teachers will have to consider their own anchoring phenomena if they wish to pursue this alternative at this time

Extension Activities

Deeper Dive

- Larry Flammer Horoscope Debunking Activity: How’s Your Horoscope?

Formative Assessments

- TBA
Online Resources

COVID-19 Theme

» YouTube Crash Course Video: Karl Popper, Science, & Pseudoscience: CC Philosophy #8
» YouTube HowCast Video: Basic Rules of Craps
» How Stuff Works article: How Craps Works
» Il Dado article: Craps Rules
» Our World in Data's Mortality Risk of COVID-19
» Mathematica's 19 and Me: COVID-19 Risk Score Calculator
» The COVID-19 Risk Calculator Project
» COVID: Can I Do It? Risk Calculator
» microCOVID Project Risk Calculator
» Georgia Institute of Technology's COVID-19 Event Risk Assessment Planning Tool

Eco-Friendly/Health Theme

» YouTube Crash Course Video: Karl Popper, Science, & Pseudoscience: CC Philosophy #8
» Medium article: What is Greenwashing? How to Spot It and Stop It
» Medium article: The Six Sins of Greenwashing


