The Misinformation Crisis

Miss - my parents read on social media that vaccinations can be bad for you: can this be true?

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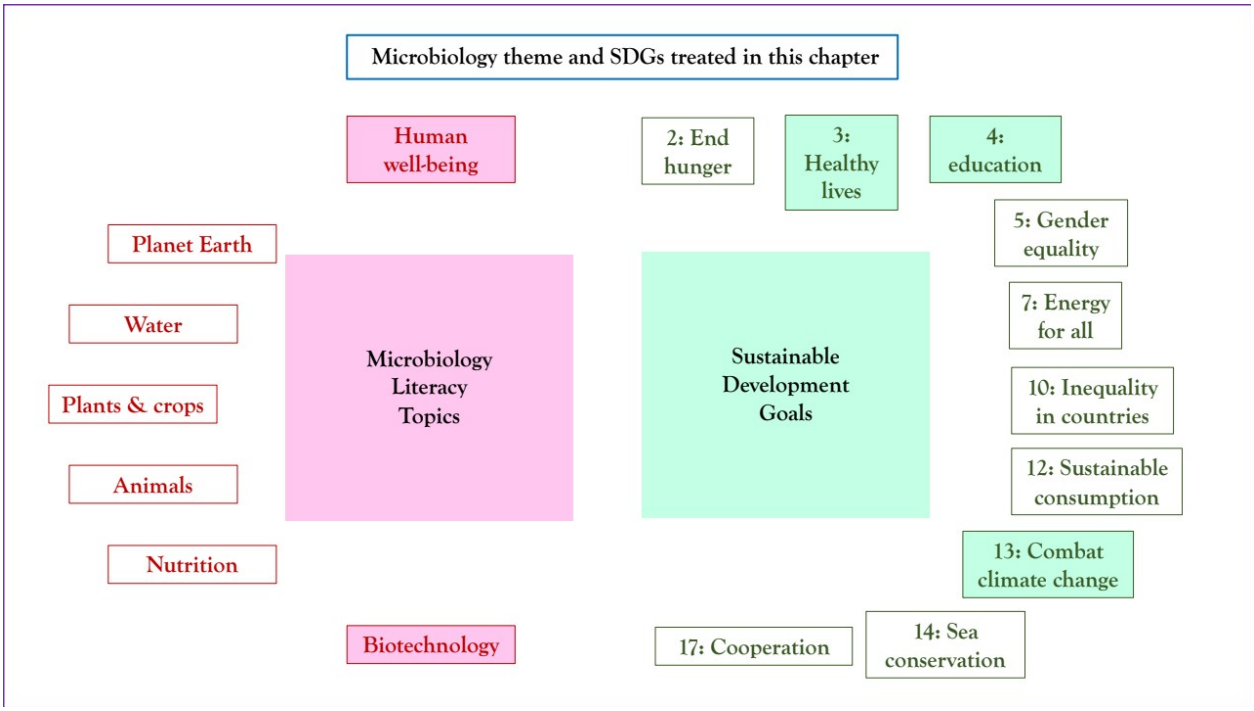
The Misinformation Crisis

Storyline

You may have heard about people in your community who are "misinformed" or have been accused of being misinformed yourself. But what is misinformation? Misinformation is when something false is presented as fact, and it has a harmful ability to spread throughout communities. Misinformation can lead people to make unhealthy or dangerous decisions, especially during health emergencies such as the COVID-19 pandemic or during elections. In serious cases, people can die due to misinformation. Some institutions that specialize in communicating information, such as scientific journals, have safeguards in place to prevent misinformation from spreading and make sure that data is ethically collected and interpreted. However, misinformation still has the capacity to spread via news outlets, social media or word-of-mouth. With enough practice, you can use strategies to identify reputable sources, fact-check claims, and see what other sources say about certain sites to identify misinformation and prevent its spread in your community. With enough patience, you can approach misinformed friends and family members to prevent misinformation spreading and keep your community safe and healthy!

The Microbiology and Societal Context

The microbiology: the scientific process, research ethics, research literacy, vaccine trials. *Sustainability*: information literacy, technology, community health



The Misinformation Crisis

1. Misinformation is when what you read, see, or hear isn't the truth. Have you ever heard something that turned out later to not be true? Maybe your friend told you "If you step on a crack, you'll break your mother's back" or if you swallow a seed, a tree would grow inside of you. Not everything we hear is correct, and this is also true of things you read in a book or on the internet.

Misinformation happens when incorrect or partially incorrect information is presented as fact. You can be exposed to information from a friend, from the Internet, or from social media. Ultimately, misinformation can spread to others like a virus when it is shared (this is what the adjective "viral" originates from).

Sometimes, people will describe misinformation as fake news. Fake news, or disinformation, is usually created by people who know what they are writing is false, but still share it on purpose to mislead others or attract attention. In contrast, satirical news writers write stories that they know are false, but they do not intend to mislead others. Instead, these writers want to make their readers laugh, and will often indicate at some point in the publication that their story is only a joke. Satire is often used to counteract misinformation, by exaggerating it to the point of the ridiculous to demonstrate its lack of plausibility. However, readers might believe that both fake news and satirical news stories are true and spread this information to others on accident.

2. The scientific process is designed to lead scientists closer to the truth. Because technology and medicine rely on scientific data, scientists cannot afford to be misinformed! To make sure that scientific discoveries are accurate and ethical, scientists ascribe to several rules. In the scientific community, the fabrication, falsification, and plagiarism of data are highly frowned upon. Fabrication occurs when a scientist makes up results based on experiments that may not have occurred. Falsification occurs when a scientist manipulates their experiment or omits information to support a false claim. Lastly, plagiarism is when a scientist tries to pass off someone else's work as their own. In the United States, researchers caught fabricating, falsifying, or plagiarizing discoveries are not able to receive funds from the government for research.

Sometimes, scientists need their experiments to be approved by an ethical board before they can even begin. In the United States, if a scientist wants to do an experiment with animals, they must seek approval from their institution's Institutional Animal Care and Use Committee (IACUC). This committee will review the scientist's procedure to make sure that it does not harm the animal subjects unnecessarily, and if the committee has a concern, they can send the procedure back to be revised. Likewise, if a scientist is conducting an experiment with humans (maybe they are testing a new drug), they would send their protocol to an Institutional Review Board (IRB) before they can even begin. In the United States, the IRB reviews research procedures to make sure that the potential benefits for participants outweigh any risk they might have from participating, while also making sure everyone participating has given their informed consent.

Once a scientist has finished their experiment, they typically will try to submit their results to one of many research journals for other scientists to read. This is because progress mostly involves advancing on a wide front, with each step depending on others made in different research groups, like a jigsaw puzzle: when you insert one new piece it can help someone else

find the next piece that fits. This is absolutely dependent on promptly sharing information with others, in the case of scientific research, by publishing in research journals.

However, to make sure that the results are valid and not misleading, journals subject articles to a process called peer-review, in order to decide whether or not to accept them for publication. In peer review, other experts in the field can read the paper and make suggestions to the scientist for revision. If the reviewers are concerned that the paper is misleading or based on incorrect methodology, they can also recommend against publication. The process of peer review plays an important role in preventing misinformation from spreading in scientific journals.

3. Sometimes, the scientific information you hear is misinformation. If peer review prevents misinformation about science from spreading, why is it still possible to hear false scientific claims? To begin, peer review is not foolproof. Sometimes papers are published in scientific journals only for individuals to learn later that the results were not valid. In this case, papers are usually retracted, or removed from journals after publication. In one analysis of thousands of retracted articles, investigators found that the majority of retractions occurred because the journal found out that the researchers committed misconduct (fabrication, falsification, or plagiarism).

A second, even more important barrier to scientific misinformation, and a central element of the scientific process, is replication. A key principle that operates in research is not to fully believe a new advance until it has been reproduced by another group. In other words, the use of a new piece of information to advance a line of research requires that it be repeated before proceeding with work based upon it. Replication is the primary means of detecting invalid results and the pivotal contributor to robust reliability in science.

One example of a retraction is a 1998 study published in *The Lancet* which suggested that vaccines against measles could cause autism in children. However, other researchers were unable to replicate its findings. In addition, it soon became apparent that the study's authors had several conflicts of interest that were not reported and had not conducted their experiments ethically. The paper was ultimately retracted from *The Lancet*, and its lead author, Andrew Wakefield, was barred from practicing medicine in the United Kingdom. However, it took 12 years for the paper to be retracted and during that time the information was used to advocate against vaccinations. Even though the paper was retracted years ago, some people still falsely believe that vaccines cause autism. This can have a dangerous effect on communities, because if parents feel hesitant about vaccinating their children, their children are more likely to get sick. This is one of many examples of the danger of misinformation.

In addition, while scientific journals are subject to peer review, the Internet, some books, and some news outlets are not. This means that anyone can say anything, regardless of if it is true. Some media outlets sensationalize the news or exaggerate it to the point that it might not be true. If someone has ever told you "Don't make a mountain out of a molehill," they are encouraging you not to sensationalize a situation. Sensational stories can happen because some media outlets receive more money if they get more viewers. When people are scared or angry about the news, they might watch more, and the outlets will receive more revenue. In other cases, sensational news is more likely to spread because, when people are angry or scared, they are more likely to share the stories with their friends.

Reporting can also be biased. If a story is biased, the writers may have a certain belief that prevents them from telling both sides of the story fairly. For example, the sports section of a local newspaper may be more likely to make you believe that their home team has better players than the visiting team. They can do this by the details they choose to include (or not include) in the article, the people they choose to interview, and even the photos they decide to use.

Scientific results can be sensationalized or reported in a biased way. Another way they can be depicted inaccurately is via the over-extension of conclusions. Imagine if, after your very first soccer practice, your coach told you could play in the Olympics the next day. Even if you were a very good soccer player, your coach is likely over-extending your abilities. In scientific papers, most scientists are careful to note the limitations of their experiments. This means that certain further experiments might be needed to make their conclusions more credible, just like you might need more soccer practice before joining a professional team.

Media outlets may disregard these limitations when reporting on scientific discoveries, making them seem more important or impactful than they are. One example of this phenomenon during the COVID-19 pandemic came from the information that cleaning products such as bleach kills the virus that causes COVID-19. This data was limited to surfaces such as floors or tables, and bleach is poisonous to humans. However, some people over-extended this conclusion by attempting to drink bleach as a treatment for COVID-19. One analysis from the *American Journal of Tropical Medicine and Hygiene* estimated that 800 people around the world died from drinking cleaning products thinking that it could cure COVID-19. In this case, individuals should consult with a medical provider before misinterpreting scientific information.

4. How can you find a reputable source? A reputable source is an article or website that will have several safeguards present to prevent misinformation from spreading. Although these sources can also be incorrect at times, these instances should happen rarely and unintentionally. In addition, reputable sources often have procedures for correcting these mistakes. For example, consider our earlier story about *The Lancet* and their decision to retract a paper that they realized was incorrect.

When looking for a reputable source, looking at the writer or creator of the video is a good place to start. Reputable creators will have some sort of authority or background on the topic that would make them more informed about it. For example, you might be a better authority on how to tie your shoes than your baby brother because you have done it many more times. However, your teacher might be a better authority on teaching science because they have been to many more years of school than you have! Some examples of authority include an educational degree or a career in the area of interest. If the creator does not have many credentials, is listed as "anonymous," or you are unable to find any information about them, this could be a sign that your source is not reliable.

In addition to this authority, reputable sources also will direct readers to other reputable sources that make their argument stronger. If you can find links or a "Works Cited" section of the article, the source is more likely to be reputable. Likewise, a source that does not have any other supporting sources is less trustworthy.

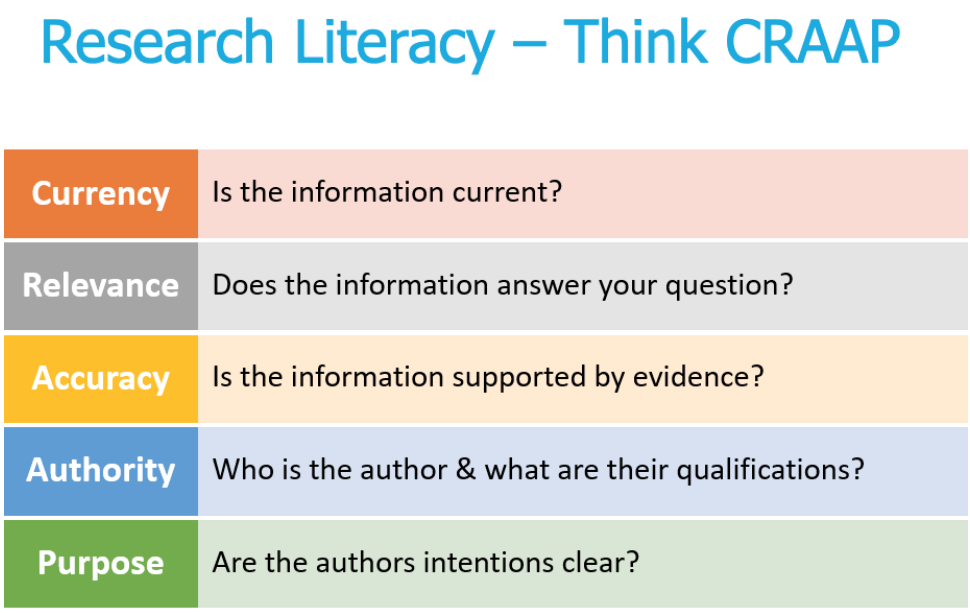
Sometimes, a source can be both reputable and biased at the same time. In the case of a newspaper, these articles might be labeled as "Opinions," "Editorials," "Letters to the Editor,"

or "Viewpoints." While these articles can still be helpful, it is important to read them while keeping in mind that the author's purpose is to persuade you to agree with them, not to inform you of objective facts.

5. What strategies can you use to spot misinformation? With enough practice, you'll be able to distinguish between accurate and misleading sources yourself! One strategy you can use to identify misinformation in stories you read is fact-checking. Some people's entire careers are based on fact-checking, but you can do it for yourself by making sure that multiple sources are supporting the same claim you find. For example, if a friend tells you that taking a vitamin every day will reduce your risk of cancer, you can fact-check this information with your doctor or a medical encyclopedia to see if this is true. If your doctor or the encyclopedia disagrees, this may mean that your friend was misinformed.

Strategies to Spot Fake News. Created by the International Federation of Library Associations and Institutions (IFLA) and licensed under CC BY-NC 4.0

Another strategy you can use to spot misinformation is called lateral reading. Lateral reading means that you are searching for information about a source as you read it. When looking for information on the source, consider using the CRAAP method to look for Currency, Relevance, Authority, Accuracy, and Purpose. If the site has not been updated for several months, its information may not be current. If the site is for hockey fans and you are looking for information about the rules of soccer, it might not be relevant. If the authors are not reputable, the source might not have authority. If other sites are accusing this source of being false, the source might not be accurate. Lastly, if other sites note that the creators of the source have a particular opinion or affiliation that biases them, you might want to consider if the purpose of the site is to inform or persuade.



Visual primer for the CRAAP Method. Created by Richard Lebert and licensed under CC BY-NC 4.0

6. Stopping misinformation keeps your community safe and healthy. Even as you now have a wealth of strategies to identify and combat misinformation, you may still hear things that are not true from friends and family. This can be a difficult situation, as you don't want to embarrass others if they are misinformed. However, it is also up to you to make sure that they are correctly informed. If your friends and family have correct, credible information, they are more likely to make healthy decisions such as taking the vaccinations or medications recommended by their doctor. In addition, communities who are correctly informed about political issues can make better-informed decisions on how to support their communities.

When talking to someone who is spreading misinformation, it is important to be patient. Remember that just like spreading a virus, many people who share misinformation are doing so unintentionally. If you feel comfortable doing so, invite the person to share where they found this information. Using your practiced skills of fact-checking, lateral reading, and the CRAAP method, you can explain how these facts may have been misinterpreted. While your friend may be embarrassed, remind them that it is easy to be misled and consider ways to correct the mistake. For example, you could encourage the friend to delete a misleading post on social

media. Ultimately, you can both choose to move on better informed about how to spot unreliable data.

Relevance for Sustainable Development Goals and Grand Challenges
(https://sdgs.un.org/2030agenda)

The misinformation crisis relates to several SDGs, including

- **Goal 3. Ensure healthy lives and promote well-being for all and at all ages** (*vaccination uptake, medication adherence, health misinformation)* Accurate health information prompts individuals to make better-informed decisions for themselves and their families.
- **Goal 4. Equitable, quality education.** Balanced, objective information is essential to opinion formation and taking evidence-based decisions. Acquisition of key knowledge and development of critical assessment skills in school are central to life-long information processing.
- **Goal 13. Take urgent action to combat climate change and its impacts** (*public information, climate change misinformation, climate policies, and democracy*) Accurate climate information prompt communities and democracies to make better-informed decisions for addressing and responding to the climate crisis.

Potential Implications for Decisions

1. ***Individual***
    a. What sources should I use to read the news every day?
    b. What impact does being misinformed have on us? How do we feel when we realize we have been misinformed?

2. ***Community Policies***
    a. Measures to counteract local public health consequences of misinformation (e.g. spread of disease due to low vaccination uptake)
    b. Measures to counteract the impact of rumors on social media on friends and family
    c. The importance of local, accessible doctors and scientific experts

3. ***National Policies***
    a. The importance of effective Institutional Review Boards and peer review systems
    b. Support funding of ethical research
    c. Balancing freedom of expression with the prevention of misinformation

Pupil Participation

1. ***Class discussion***
    a. [If students are older] Where do you get your news every day? Do you think that is a reliable source?
    b. [If students are younger] Ask your parents where they get their news every day. Are there any differences in the class?

c. Have you ever learned something you thought was true was false? How did it make you feel?
d. Has someone ever told you something that you immediately knew was untrue?
e. How could misinformation impact our class? Our community? Our country?
f. Did you know anything about research ethics or peer review before this class? How does it change the way you think about scientists?

2. ***Pupil stakeholder awareness***
    a. What strategies do you use to determine if the information you find is correct or not?
    b. Who do you trust to provide you with accurate information? What makes them trustworthy? Why?
    c. What do you think are some ethical rules scientists should follow when working with human subjects?

3. ***Exercises***

Younger Students

- Have students play a game of telephone (see below) to demonstrate how quickly a rumor can spiral out of control. Students sit in a circle and the starting person whispers a word or phrase in the ear of the person next to them just once. This person whispers what they heard into the next person's ear until the circle is complete. Usually, the word or phrase changes substantially!
- Invite students to make a T-chart of statements that are facts and statements that are opinions.

Older Students

- Play the Go Viral Game (see below) to see what tactics people use to misinform others and how false information spreads online
- Play the Doubt it or Trust it Game (see below) to see if you can spot misinformation
- Bring different news articles to class and compare their credibility. Look for CRAAP criteria.

The Evidence Base, Further Reading and Teaching Aids

Younger Grades (Ages 9-12)
Common Sense Media: Five Ways to Spot Fake News
BrainPOP: Fact vs. Opinion
The Telephone Game: How Rumors Can Spread

Older Grades (Ages 13+)
Bioethics: Fabrication, Falsification, and Plagiarism
Sample IRB and IACUC Instructions from Mt. Sinai Hospital
The Peer Review Process as Explained by a Scientific Publisher

Scientific Retractions are Mostly Due to Research Misconduct
Crash Course: Navigating Digital Information Series
Deaths from Misinformation During COVID-19 Pandemic
The Centers for Disease Control: Addressing Misinformation from Friends and Family
TED-Ed: How False News Can Spread
https://www.youtube.com/watch?v=3-d_VlCQWF0
Identifying Sensationalist Tactics
Scientific Article on Andrew Wakefield and *The Lancet* retraction
Lateral Reading and the CRAAP Method
Go Viral Game
Doubt it or Trust it Game

Glossary

Authority: background on a topic that makes someone qualified to explain an issue or inform the public
Bias: a pre-existing belief that can prevent someone from accurately explaining a topic
CRAAP method: a set of criteria for evaluating the validity of a source. It stands for currency, relevance, authority, accuracy, and purpose.
Fabrication: when a scientist makes up results based on experiments that may not have occurred
Fact-Checking: the act of making sure that a claim is agreed upon by multiple sources
Fake News: false information often deliberately published for purposes of attracting attention or deceiving others
Falsification: when a scientist manipulates their experiment or omits information to support a false claim
Institutional Animal Care and Use Committee (IACUC): A committee placed in charge of ensuring that the animal research performed at their institution is ethically designed
Institutional Review Board (IRB): a committee placed in charge of ensuring that the human subject research performed at their institution is ethically designed
Lateral Reading: the act of seeing what other sources have to say about a particular source
Limitations [of an experiment]: restrictions on the interpretation or applicability of a scientific finding due to the need for further research
Misinformation: incorrect or partially incorrect information is presented as fact
Peer review: a process in which scientific experts can review and make suggestions to scientific studies ahead of publication to the broader public.
Plagiarism: when a scientist passes off someone else's work as their own
Reputable Source: a source that has several safeguards present to prevent misinformation from spreading
Retraction: the process by which an article is removed from a journal after publication, often due to concerns about the article's validity
Satirical News: false information deliberately published for purposes of entertaining readers, who are aware that the story is a joke
Sensationalize: to exaggerate information to the point that it is no longer accurate