SCIENTIFIC INQUIRY

THE NEED FOR SCIENCE: CORRELATION VS CAUSATION

MODULE 1

WARM-UP DISCUSSION

1. What is science? What separates ‘real’ or ‘good’ science from ‘fake’ or ‘bad’ science?
2. How do scientists design experiments? What process do they use?

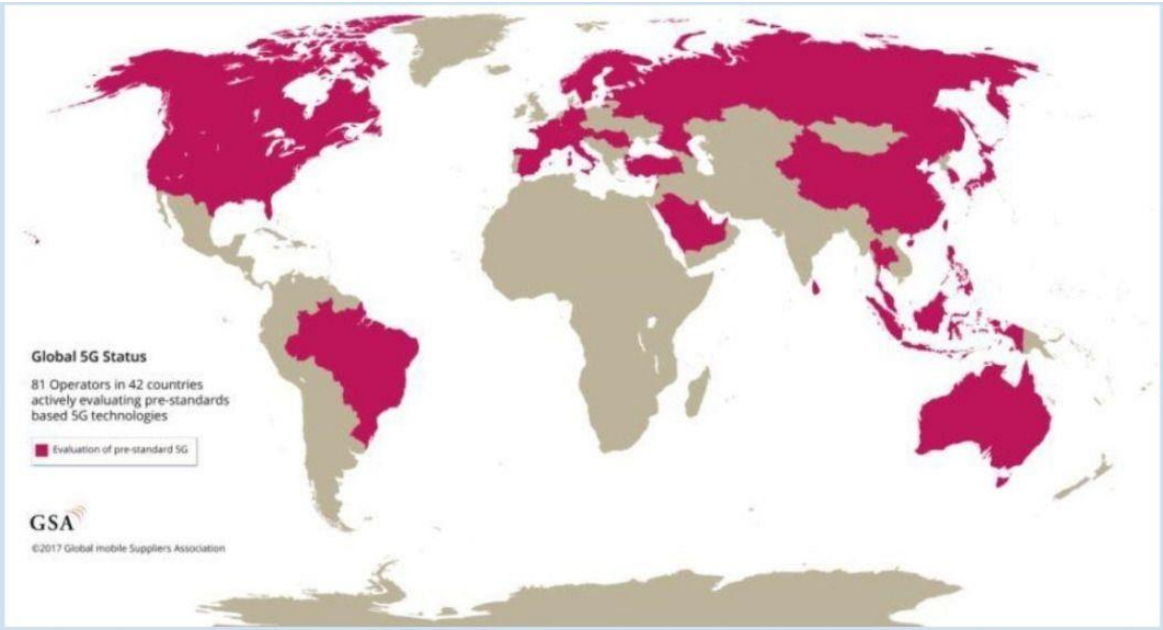
CLAIM: "5G CAUSED COVID-19"

Source: The Science Page

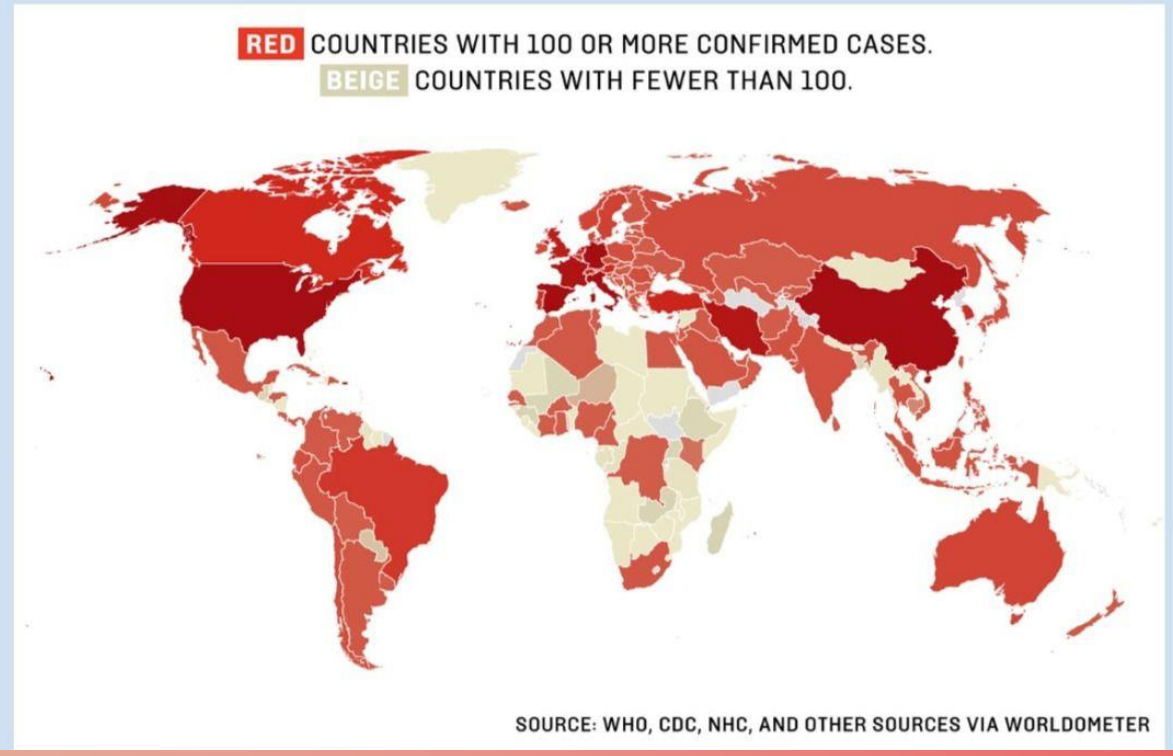
CLAIM: "5G CAUSED COVID-19"

Source: iAfrikan.com

5G



Covid-19



CLAIM: "5G CAUSED COVID-19"

Source: Manchester Evening News

CORRELATION IS NOT CAUSATION

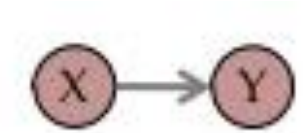
Correlation is a mutual relationship or connection between two or more things (Oxford Dictionary)

The maps show a correlation between 5G coverage and COVID-19 cases. But they do not prove that 5G ***causes*** COVID.

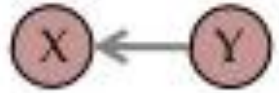
CORRELATION IS NOT CAUSATION

It is fairly straightforward to show that two variables are related (***correlation***).

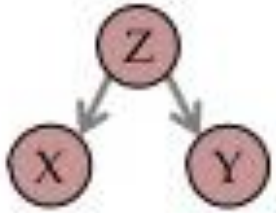
But to show ***causation*** (that x causes y), we need to conduct a controlled scientific experiment.



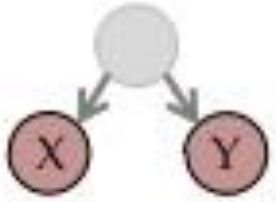
X causes Y



Y causes X



Z causes X and Y



hidden variable causes X and Y

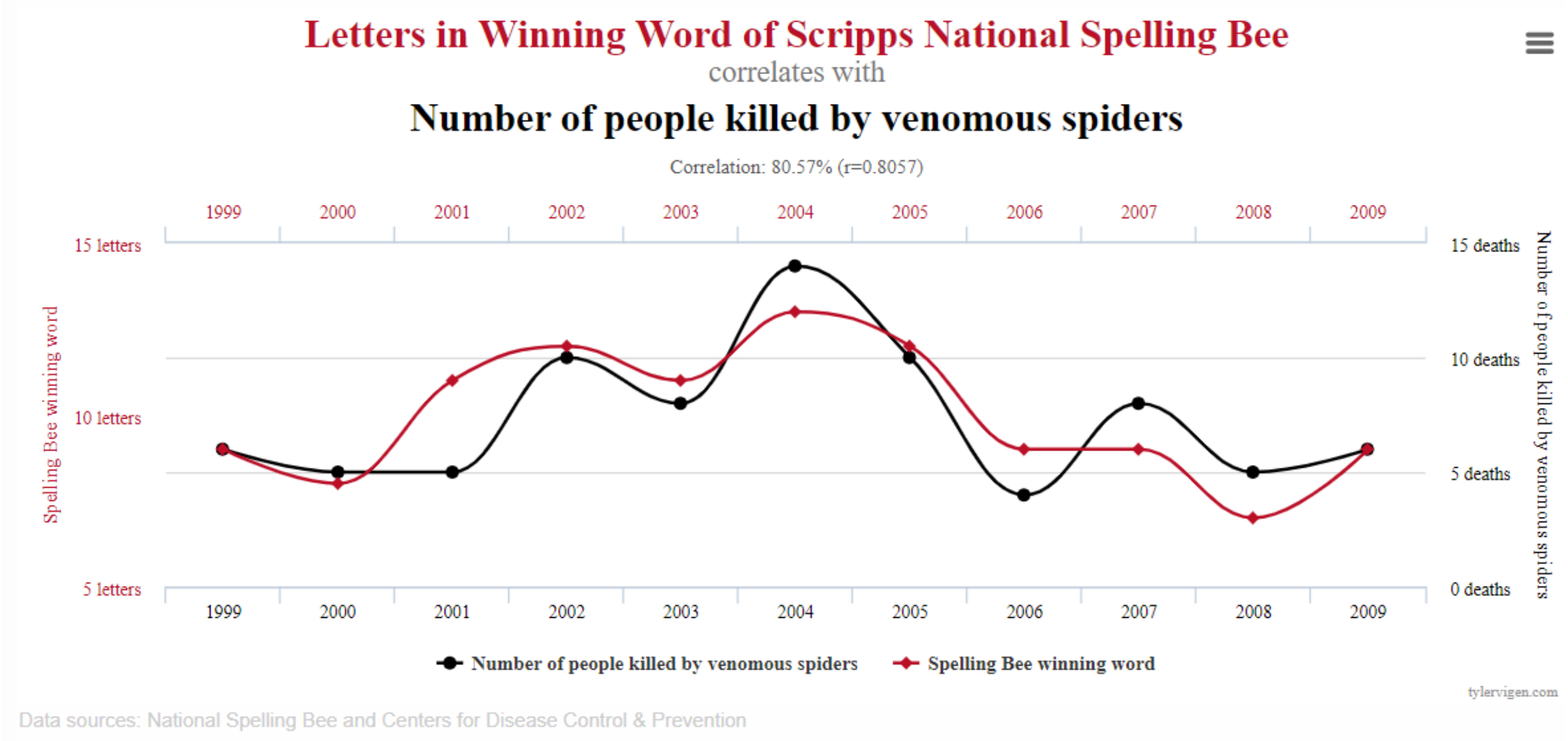
random chance!

https://www.slideshare.net/JonathanStray/frontiers-of-computational-journalism-week-4-statistical-inference

CORRELATION IS NOT CAUSATION

https://www.youtube.com/watch?v=VMUQSMFGBDo&ab_channel=DecisionSkills

https://www.tylervigen.com/spurious-correlations



Data sources: National Spelling Bee and Centers for Disease Control & Prevention

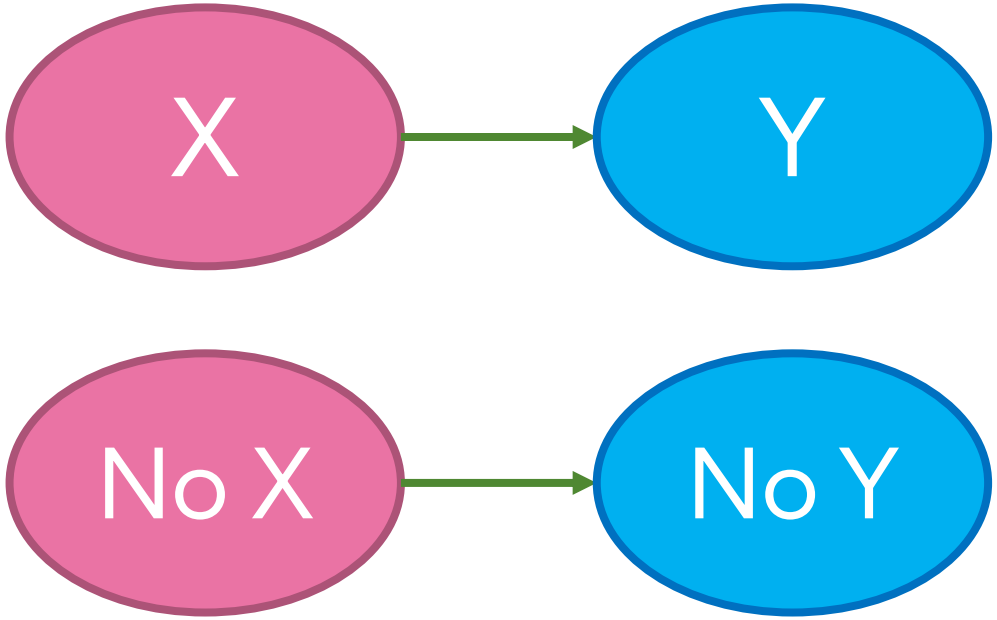
YOUR TURN!

On a sheet of paper, define correlation and causation in your own words.

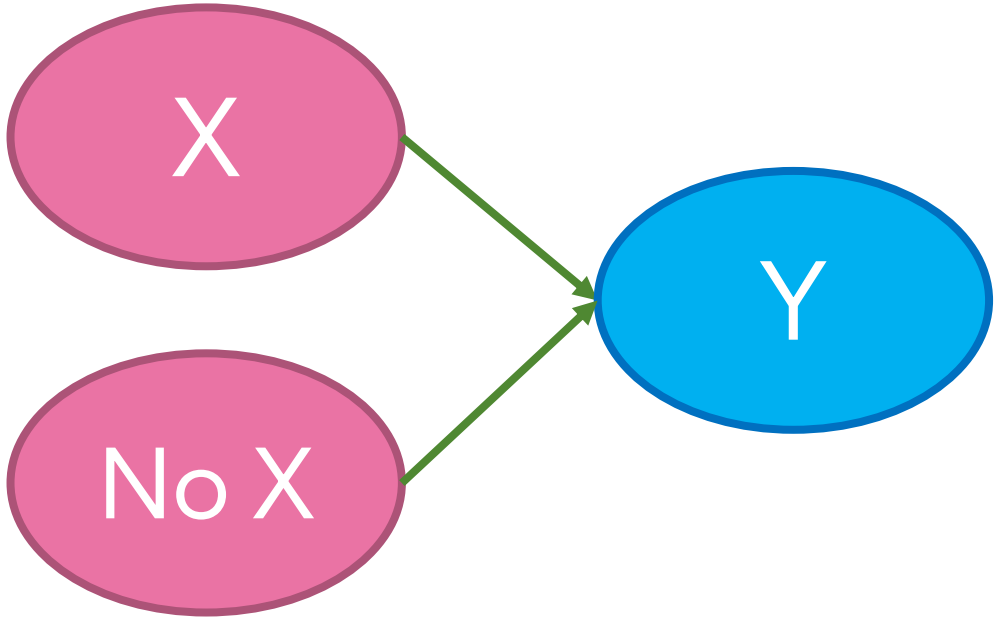
Give an example of each to help you understand them.

EXPERIMENTAL DESIGN: BASICS

Hypothesis: X Causes Y



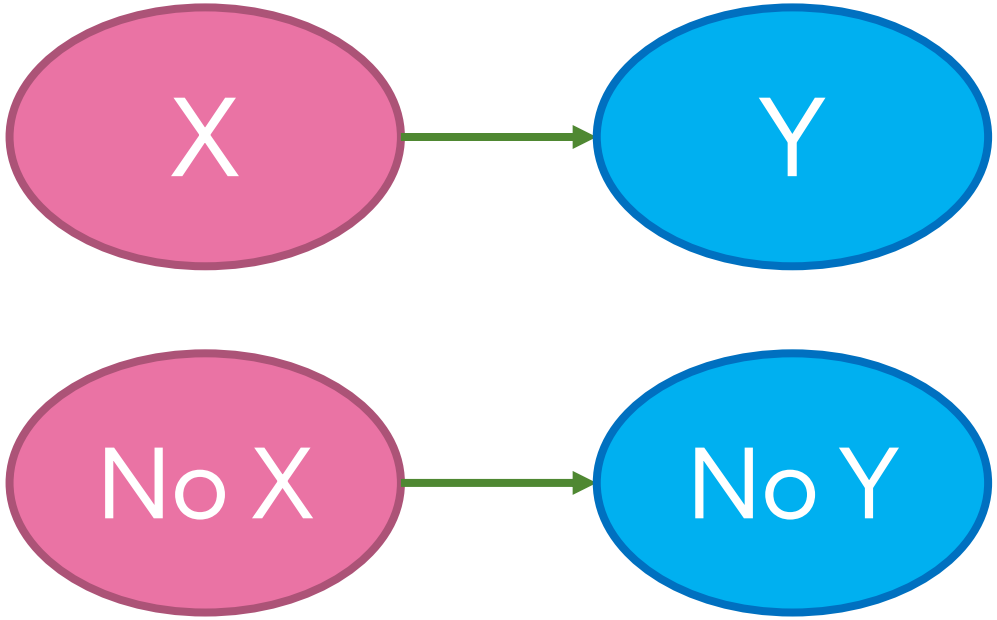
Conclusion: X Causes Y.



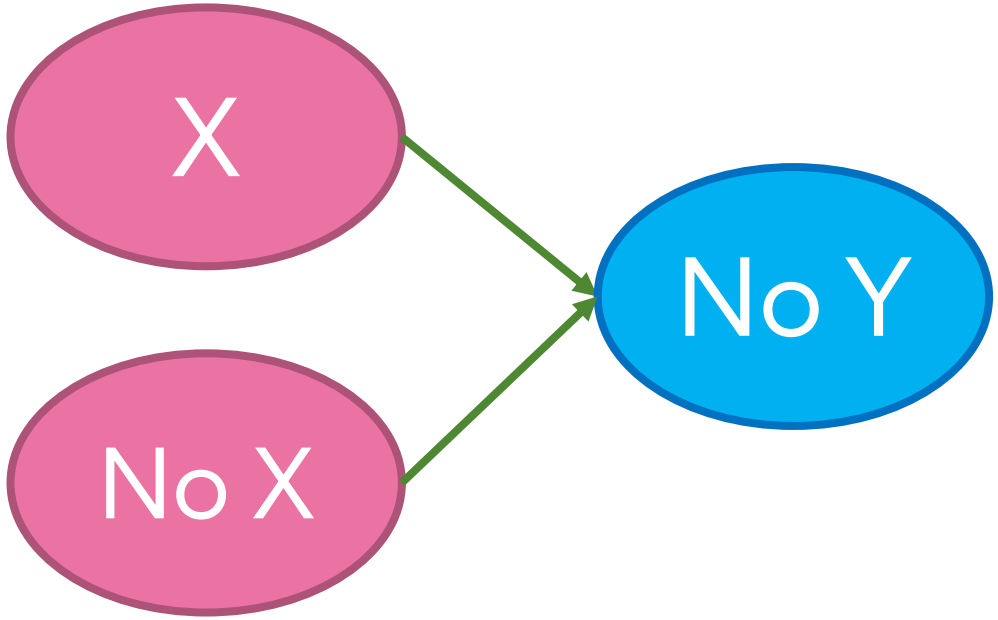
Conclusion: X does not cause Y.
Something else causes Y.

EXPERIMENTAL DESIGN: BASICS

Hypothesis: X Causes Y



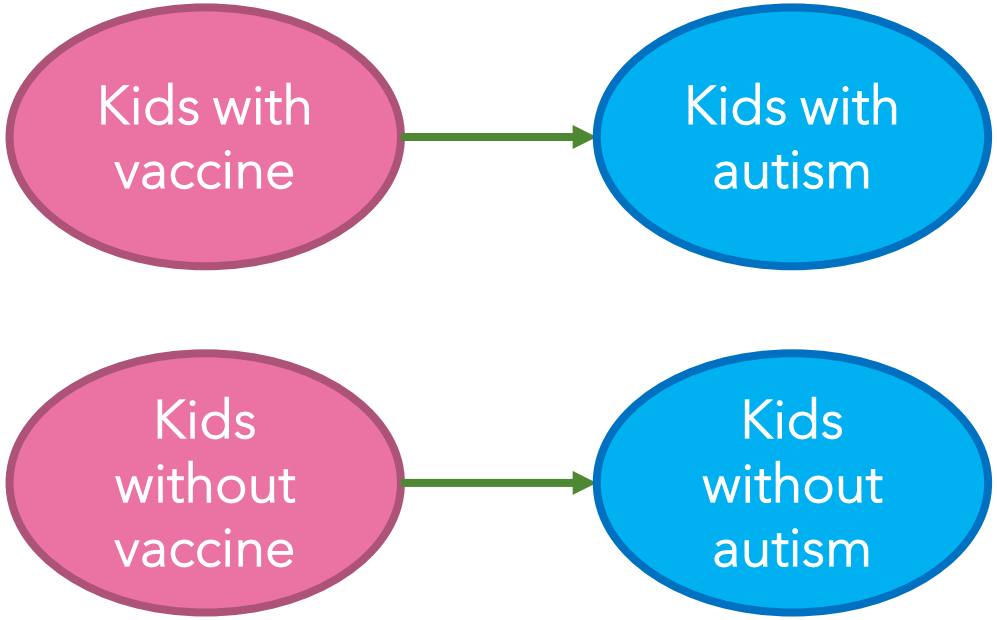
Conclusion: X Causes Y.



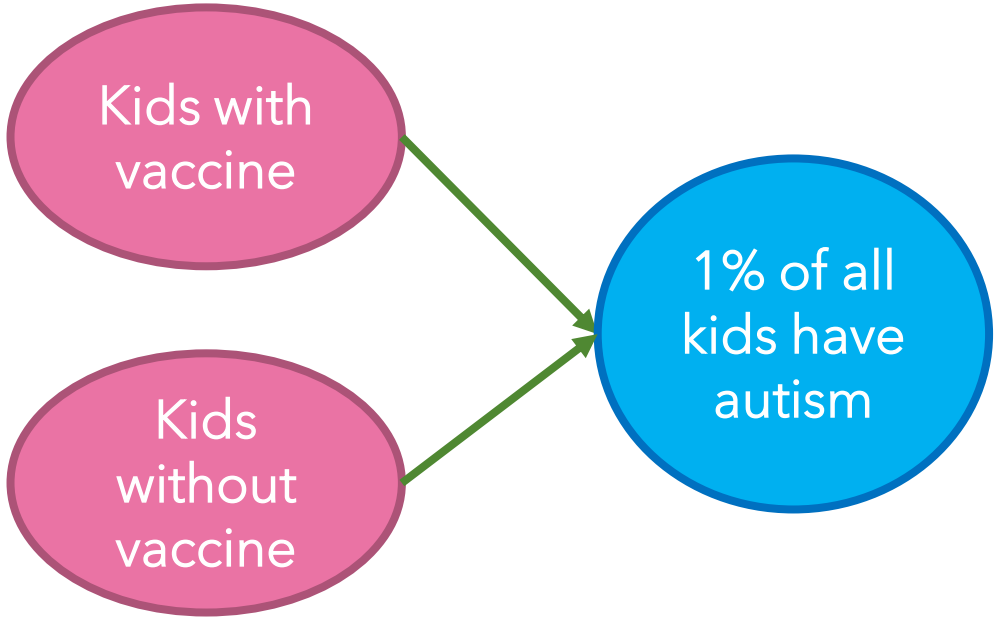
Conclusion: X does not cause Y.
Something else causes Y.

EXPERIMENTAL DESIGN: BASICS

Hypothesis: Vaccines cause Autism



Conclusion: Vaccines cause autism.



Conclusion: Vaccines do not cause autism. Something else causes autism.

DIFFERENT 'EXPERIMENT' TYPES

Observations: making observations in an unstructured way; is not a real experiment but can lead to formation of an experiment

"What colour is ___?" "What does ___look like?" "What happens if I do ___?"

Correlational Experiment: examines the correlation between two variables where manipulation is not possible; cannot claim causation

"How does ethnicity affect salary?"

"How does being dropped on the head at birth affect intelligence?"

Controlled Experiment: controls all variables except independent variable; can claim causative relationship between x and y

"How does watering amount affect plant growth?"

"Does the vaccine reduce the risk of catching COVID-19?"

GOOD EXPERIMENTAL DESIGN

- Other than "X", everything else is the same in your two versions of the experiment
- Repeat the experiment in different settings, with different subjects (if applicable)
- Measurement is objective and free of bias

EXPERIMENTAL DESIGN: SIMPLIFIED

MODULE 2

WARM-UP

What would you do in each of the following scenarios? Discuss the steps you would take, in the order you would take them.

1. You have a cough and are feeling sick.
2. You typed in the URL but you cannot access Ms. Au's website on your phone.
3. Your favourite phone game just released a new update! But when you updated the app, the game does not start up on your phone anymore.
4. Your combination lock on your locker is not opening.
5. You have plugged in and turned on the hot plate, but it is not getting hot even after waiting 10 minutes.

Steps of the Scientific Method

CASE STUDY: FEELING SICK

OBSERVATION: You have a cough and are feeling sick.

QUESTION: Why am I sick?

-research-

HYPOTHESIS: Maybe I have COVID-19.

EXPERIMENT: Do a rapid test.

RESULT: Positive.

Multiple courses of action you could take at this point…

CASE STUDY: WEBSITE WOES 1

OBSERVATION: You typed in the URL but you cannot access Ms. Au's website on your phone.

QUESTION: Why can't I access Ms. Au's website?

-research-

HYPOTHESIS 1: Maybe the website is down.

EXPERIMENT 1: Try on a different device or ask a friend.

RESULT 1: Ms. Au's website works on other device.

CONCLUSION 1: Website is not down. Must be something else.

CASE STUDY: WEBSITE WOES 2

HYPOTHESIS 2: Maybe my wifi is not working.

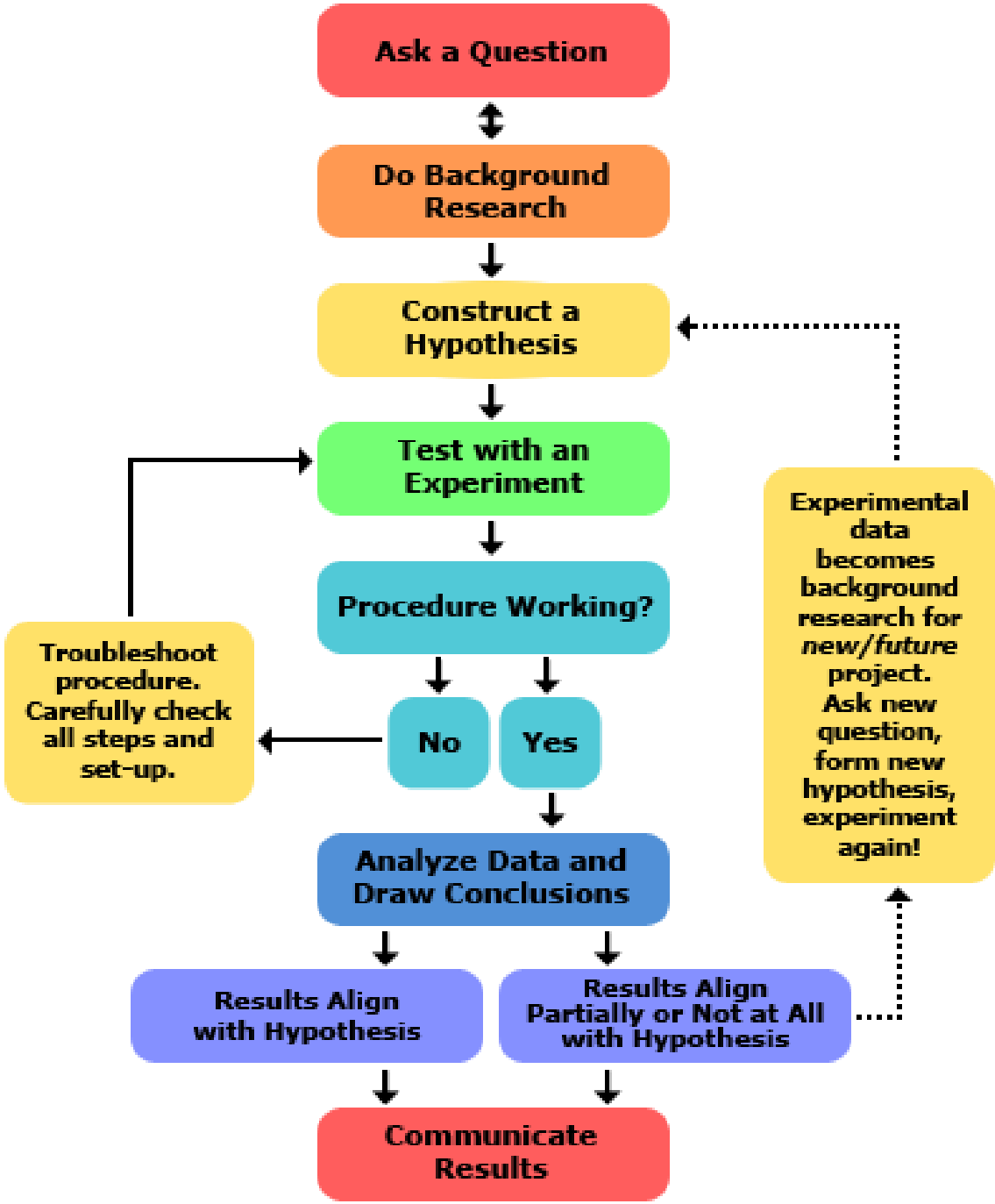
EXPERIMENT 2: Try to visit a different webpage.

RESULT 2: Other webpage works fine.

CONCLUSION 2: My wifi is fine. Must be something else.

…

THE SCIENTIFIC METHOD



THE SCIENTIFIC METHOD

You use the scientific method in your everyday life, even if you are not thinking about it!

1. Observe something that prompts you to ask a question.
2. Conduct extra research. Create a hypothesis.
3. Design and carry out an experiment that will help you test your hypothesis.
4. Interpret the results and draw a conclusion.
5. Repeat, if necessary!

THE SCIENTIFIC METHOD

Hypothesis: a research-based explanation that can be proven (or disproved) using an experiment

Observation	Good Hypothesis	Bad Hypothesis
The sky is blue.	Dust particles in the sky scatter blue light into the atmosphere.	1000 years ago, an invisible Blue Whale god threw up in the sky. Its vomit was blue.
My phone won't turn on.	The phone is out of battery.	The ghost of Steve Jobs is haunting my phone and cursing it because I have an android phone.
I am struggling in school.	I am not studying enough.	I was dropped on the head as a baby.*

* While it is impossible to prove that the reason YOU are struggling in school is because YOU were dropped on the head as a baby, it is possible to answer a different question…e.g. Do babies who are dropped on their heads go on to struggle more in school than average?

CASE STUDY: "HOW TO SURVIVE SPICY FOOD!" VIDEO

https://www.youtube.com/watch?v=v0So51Q6GLg&ab_channel=TheFoodTheorists

1) What question is being investigated here? (Hint: Be ***specific*** about what is being investigated in this particular series of experiments. The answer is NOT "How to survive spicy food?")
2) What molecule is found in spicy foods?
3) What is the name of the receptor in your body that detects spiciness?
4) Experimental Design:
    a. What is the one thing that is changing every time they do a new 'round' of experimentation?
    b. What are some things that stay the same throughout all the rounds of experimentation? Extension: why is it important that these things are not changing?
5) How did the experimenters determine which chaser was the most effective? Propose a ***better way*** of measuring chaser effectiveness. (You may need to think outside the box for this question.)

CASE STUDY: COMPETITIVE EATER VIDEO

https://www.youtube.com/watch?v=jfFD1c2H9Ek&ab_channel=VarietiED

EXPERIMENTAL DESIGN

Question: How can you make a paper airplane that flies the farthest horizontal distance?

Task: Use the scientific method at least twice to come up with the best airplane design.

Important Note: Every time you do a new experiment, only change ONE thing at a time. E.g. if you change paper to cardstock AND change the way you fold your airplane, you won't know why the result is different.

MAKING OBSERVATIONS AND MEASUREMENTS LIKE A CHAMP

Module 3

REVIEW: DATA TYPES

1. What is quantitative data? Give 3 examples.
2. What is qualitative data? Give 3 examples.

REVIEW: DATA TYPES

Quantitative data:

- Collected using measurement tools and techniques
- Described using numbers and values
- Objective
- Examples: 3 cm, 100 km/h, 5°C, 700 nm light

Qualitative data:

- Collected using the five senses
- Described using words
- Subjective
- Examples: small, very fast, cold, pink

ACTIVITY 1: OUTSIDE THE BOX

Often in science, you will need to measure things that are not 'easy' to measure because they are abstract or because of equipment limitations.

Brainstorm how you could measure each of the following:

- Time (without any electronic device)
- Mass/weight (without a scale)
- Temperature (without a thermometer)
- Distance (without a ruler)
- Speed a mouse is running
- Happiness
- Plant growth
- Intelligence

CASE STUDY: BEST FRIES SIZE

https://www.youtube.com/watch?v=c_jnZkVlNtw&t=466s&ab_channel=TheFoodTheorists

As you watch:

1) Good scientific experiments involve replication: making the same measurement more than once to ensure that your results are not an accident or a 'fluke'. How is replication shown in this video?
2) The variables being measured are: cost per gram, fry fill percentage, and calories per cent. Classify each variable as qualitative or quantitative.
3) Why did MatPat measure "fry fill percentage"? What question was he trying to answer?
4) How did MatPat measure "fry fill percentage"? Use this example to explain why creativity is often necessary when designing science experiments.

ACTIVITY 2

Question: How can I make an aluminum foil boat that will hold the most weight?

Important Notes:

- For your boat, you can only use the 6"x 6" square of aluminum foil given to you by your teacher. You can cut, glue, fold, tape that piece of aluminum foil if you want.
- Each group will only be given 2 pieces of aluminum foil for their testing process, and 1 more for their final boat. *Do not waste it*. Ensure you research and make a plan before getting your aluminum foil.
- Document your experimentation process using the provided template. This will be submitted to your teacher.

End of slides for 2022-2023 Science 9