CRITICAL THINKING: EXAMINING CONTROVERSIAL "POP-SCIENCE" ISSUES IN STEM

STEM GATEWAY

SURVEY

http://goo.gl/luGp6u

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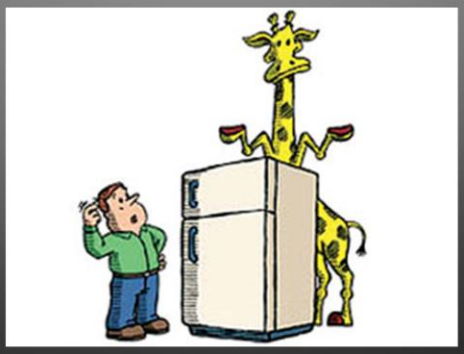
STEM Gateway

What are your initial thoughts are to the topic “critical thinking”. What do you think this means? (discuss) we’ll keep all of that in mind as I go through this presentation.

HOW DO YOU PUT A GIRAFFE INTO A REFRIGERATOR?

- Open the refrigerator, put in the giraffe, and close the door



Let's start out with a quick reflection on how you think. Answer this question.

(*) Was your answer more complicated than this? Do you do simple things in an overly complicated way? What is underlying your thought process?

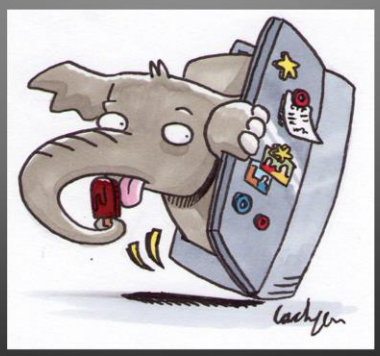
METACOGNITION AND CRITICAL THINKING

- Awareness of your own thought process and strategies.
- Always ask:
  - Why?
  - How?
  - What if?
  - Bias or delusion?

This is to the concept of Metacognition.
(*) Essentially, think about how you think, reflect on your own thought process and strategies for building what you think, believe or do.
(*) To effectively do this, when you are presented with a concept or task, always ask yourself: why, how, and what if's about the topic. It is also important to understand where you currently stand on the topic, so reflect to see if you have pre-formed opinions, and what is the root of those opinions.

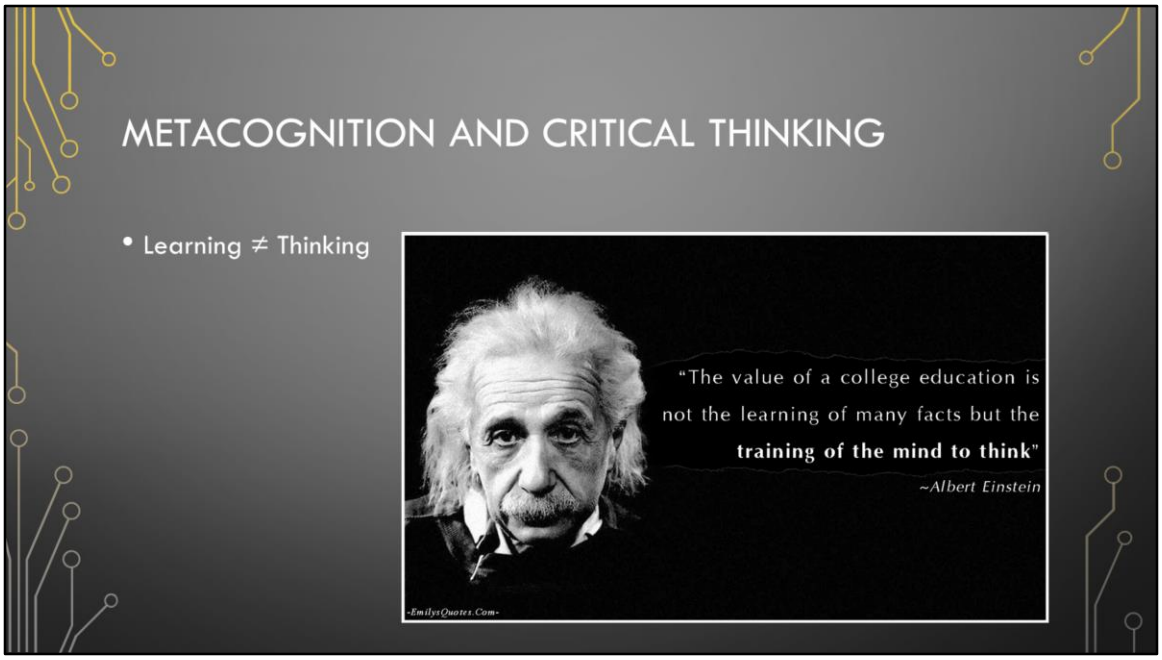
HOW DO YOU PUT AN ELEPHANT INTO A REFRIGERATOR?

- Open the refrigerator, take out the giraffe, put in the elephant and close the door



Now that you know you have to think about your thought process, let's try that again…
Did you say, Open the refrigerator, put in the elephant, and close the refrigerator?
Not this time.

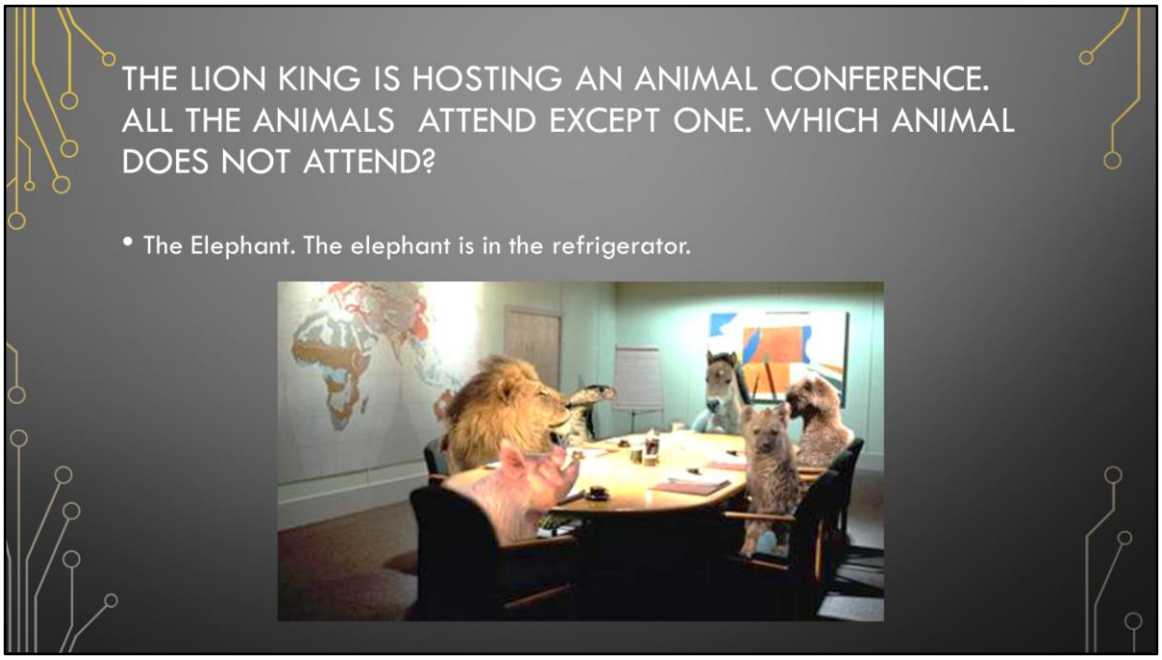
(*) This tests your ability to think through the repercussions of your previous actions.



When we try to reflect on how we think, and actively thinking critically it is sometimes a difficult thing to achieve and takes practice. It's easy to sit through a class, memorizing some facts and working through assignments with minimal effort, without ever actually engaging with the scientific process that puts critical thinking into practice.

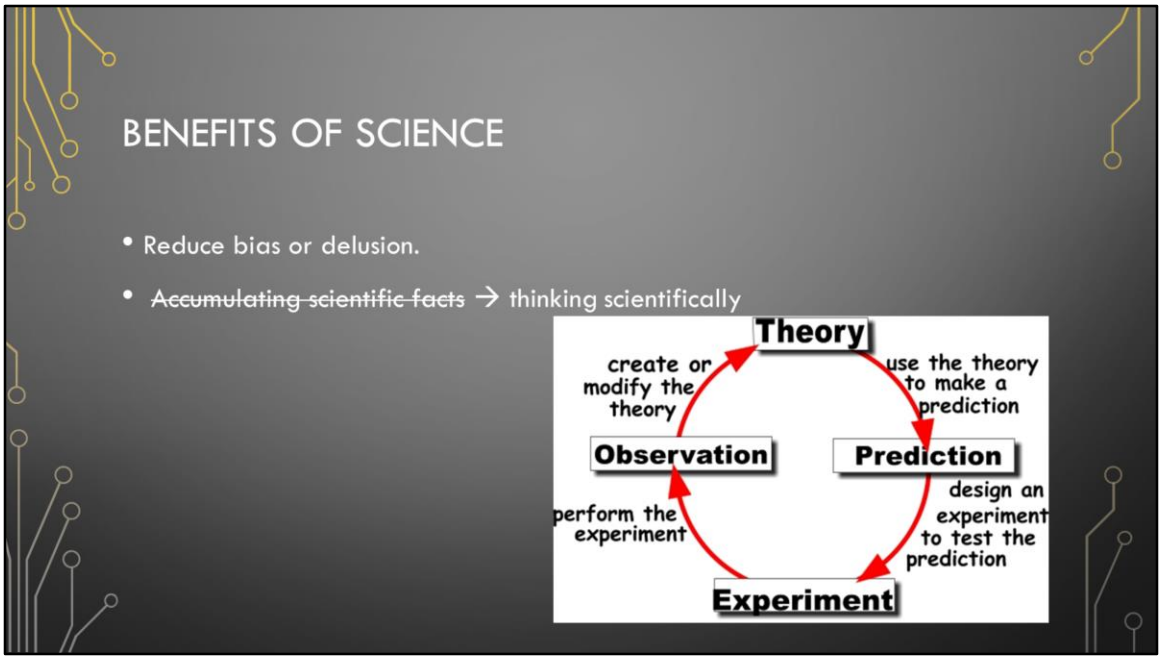
(*) One thing to remember is that learning is not thinking. As Albert Einstein expertly put it, "the value of a college education is not the learning of many facts, but the training of the mind to think".

This is a challenge because we are often exposed to broad misconceptions. And, having established methods presented to us doesn't usually affect these beliefs. Unless you practice expressing and defending their own beliefs, and listen critically to those of others, they will not critique their own beliefs and modify them in light of what they learned.



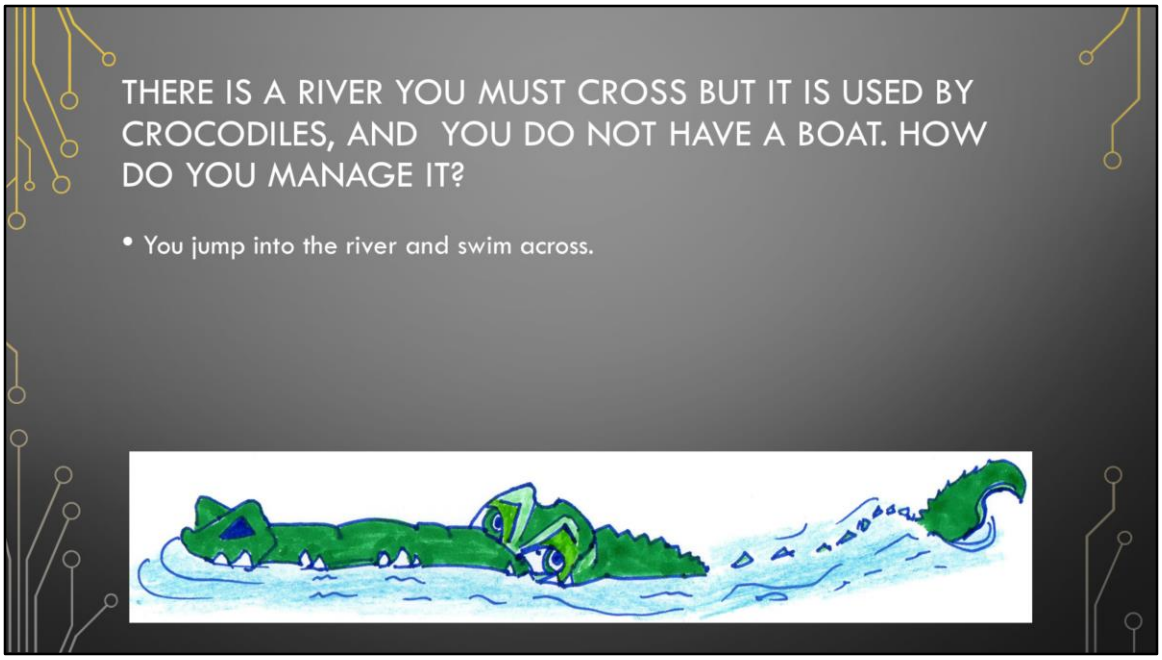
So, let's see if you learned AND are thinking. Paying attention to the repercussions of your previous actions...

(*) You just put him in there. This tested your memory, did you remember what actions you previously took?



There is a benefit to using the scientific proses in applying critical thinking skills. You have to remember, science is not the finished product that is often encountered, but a process of trial and error through the scientific method and critical thinking.

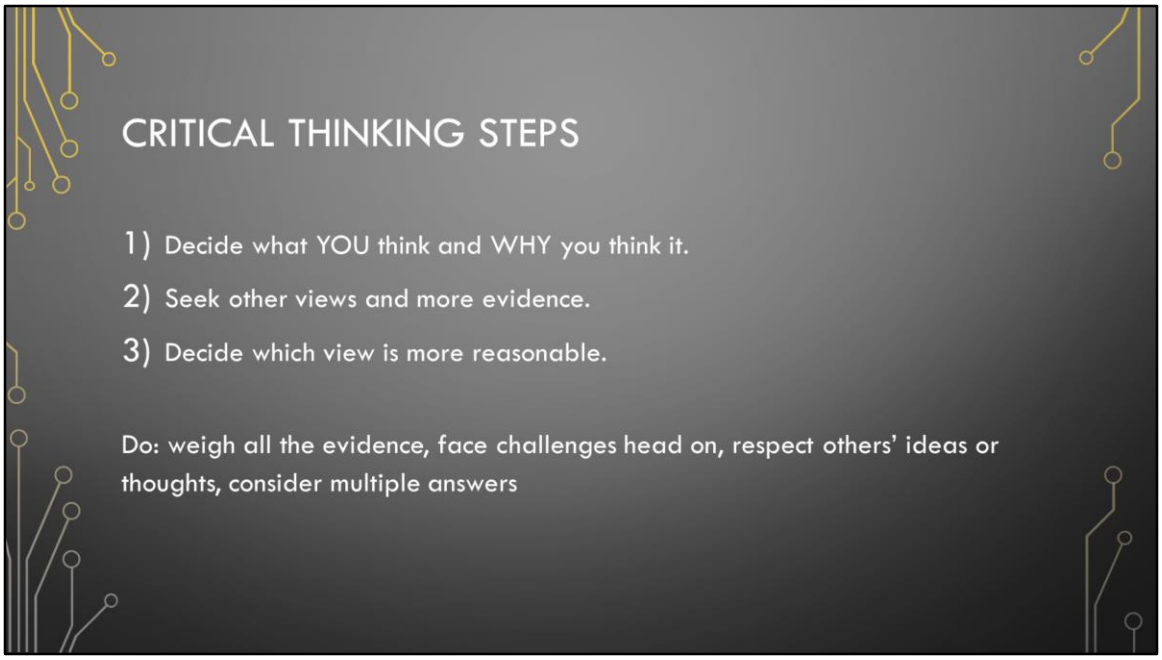
(*) The scientific process helps reduce the probability that our own viewpoints are influencing our conclusions.
(*) Sure, we need foundational knowledge to help us in this process, but it's more about the application of that knowledge than the facts themselves. Just like in the last question, the knowledge about where the elephant was would allow you to accurately answer the question.



So, let's tie this all together.

(*) All the crocodiles are attending the Animal Meeting. This tests whether you learn quickly from your mistakes, specifically, of not remembering your previous actions and their consequences.

So what did you just learn? Don't over complicate things, one action affects another, and it's important to remember what you have already done, and really THINK actively about your thought process and how you process information.



Within critical thinking, there are three major steps you can take to help train your mind.

(*) First, decide what YOU think and WHY you think it, but make sure you allow your opinion to change throughout the remainder of the process. Even if a course or topic is presented in a lector based format, you can try to expand your horizons past what you already know. You can even generate a list of questions and look for answers. If you don't have thoughts about the topic, talk about it with somebody else to see if their thoughts spark something. If you are not interested in the topic, find out why you are not interested in the topic.

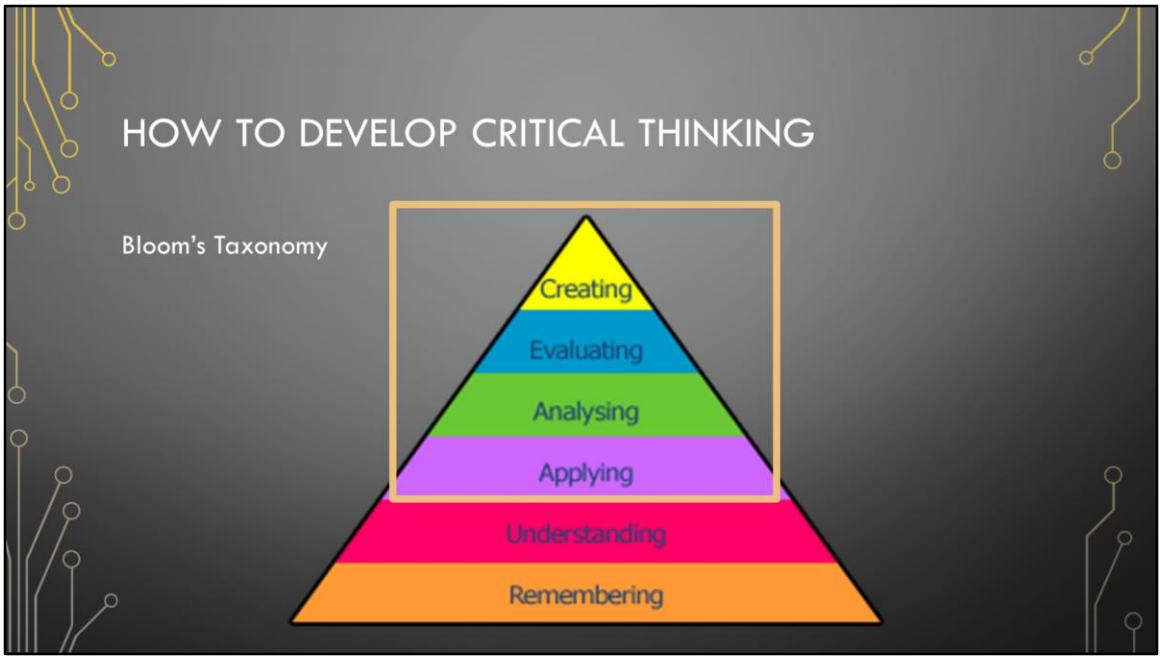
(*) Tied to this is to think about the topic in another way. Ask other people about their views, or seek out more evidence. Find academic sources on the topic. Speak with other people to get a different perspective. How do your thoughts now compare to before doing this? In this type of situation, it's healthy to doubt yourself and re-think about your conclusions, are you too rash, trying to find the "right" answer, were your interpretations correct?

(*) Lastly, try to distinguish the different perspectives. Make pro/con or like/dislike lists. consider all evidence without bias. Which position is MORE valid? Which is more convincing, which is more realistic?

(*) More importantly, weigh all the evidence, face challenges head on, respect others' ideas or thoughts, consider multiple answers

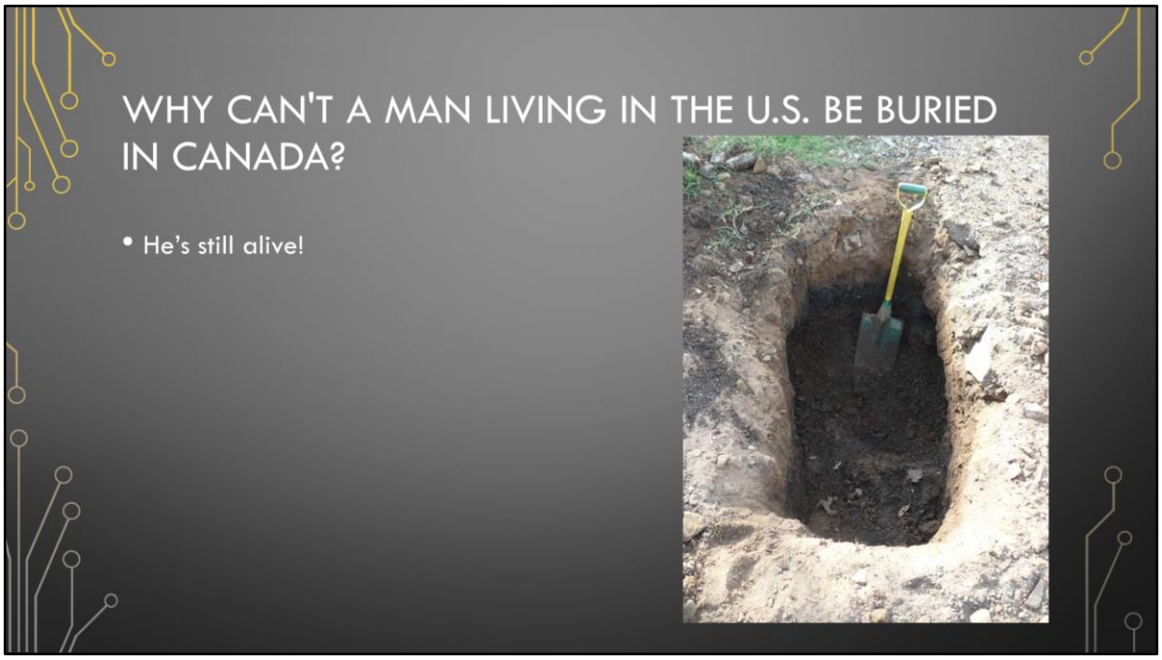
Now that your mind is warmed up, here's another question.

(*) One per year. It didn't ask how many birthdays the average man has in his lifetime, although it didn't explicitly say per year, either. Pay close attention to how questions are stated and what is omitted.



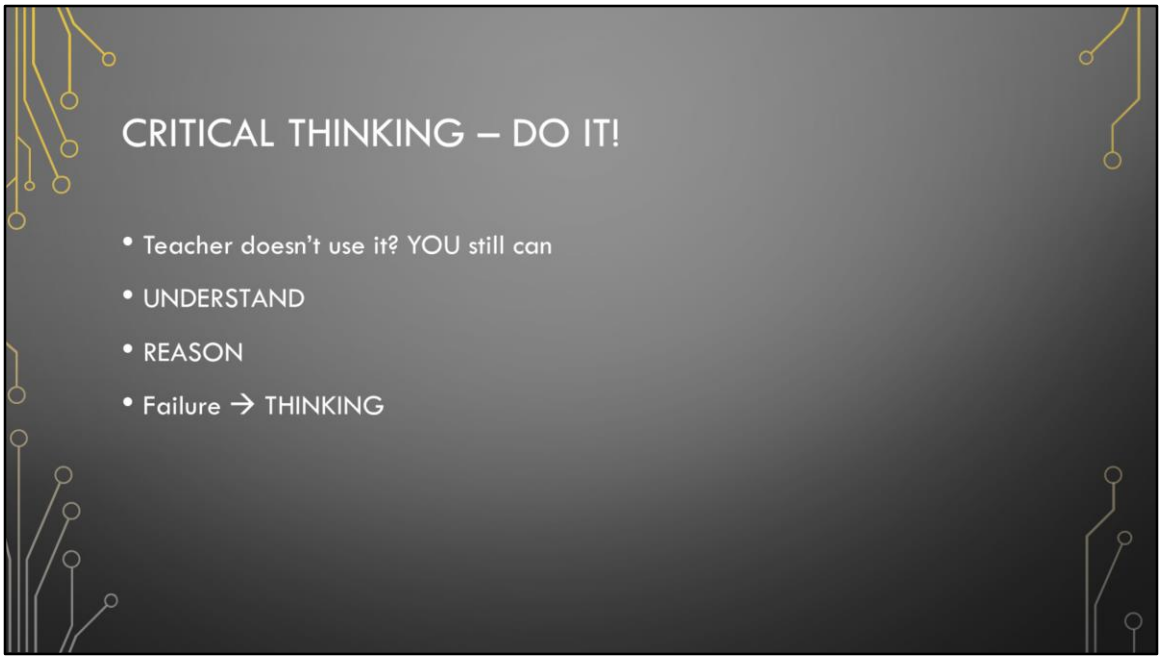
Within our thought process, there are 6 major phase, often referred to as Bloom's taxonomy.
First you have to be able to attain knowledge and remember facts. You can ask simple questions like How many, or what happened when.
Next is understanding. To test this, try to write the concept in your own words.
(*) The remaining steps of the pyramid are where critical thinking starts to come into play.
Applying the information you just gained. Ask things like Do you know another instance when?
Next is analyzing the information. Which events could have happened? Or how was this similar to? You need to break down, the parts and manipulate it through things like categorization, deconstruction. Try to identify and examine arguments, assumptions, claims, subjectivity, and agenda, bias.
After you do this, you are able to evaluate or synthesize the issue. Can you see a possible solution? How many ways can you this be done? This is when you can determine the validity or significance of something based on the evidence, claims, assumptions, biases, perspectives, etc.. You can conjecture alternatives, drawing your own conclusions, and apply reason.
Lastly, you can finally creating. Is there a better solution to? How would you have

handled? Make sure you include a reflection or self-examination.

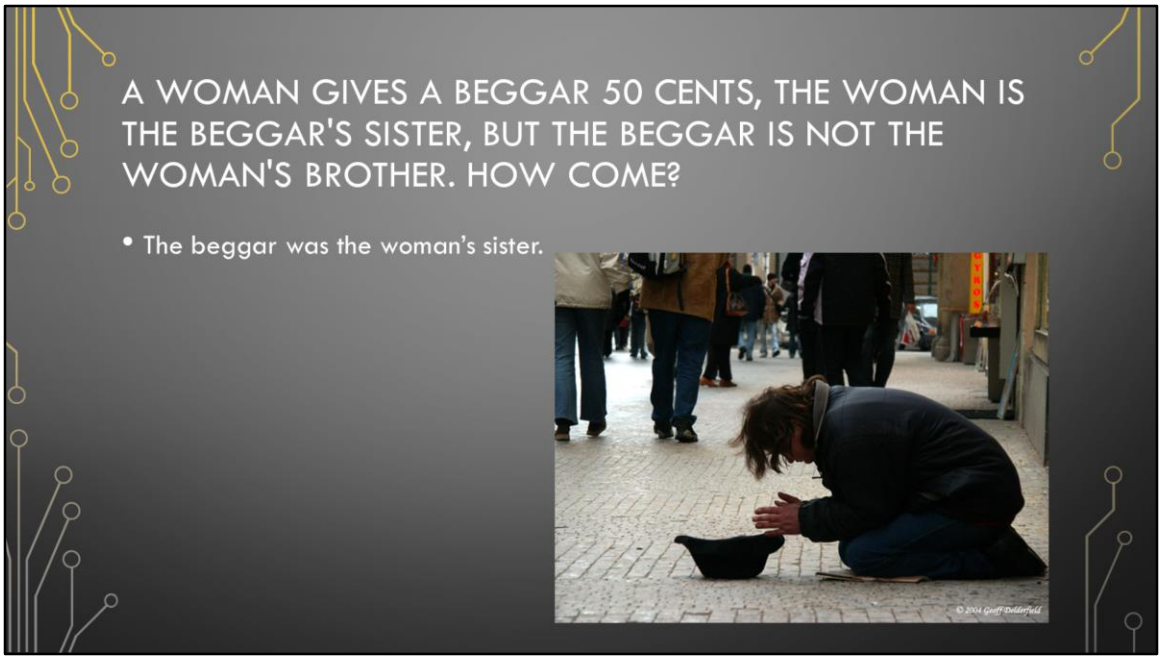


Keeping that in mind, and everything you've learned so far, this one should be easy.

(*) Did it take you a second to figure this one out? Why? Again, you can see how you need to pay attention to what is actually being said, rather than what you pick up on a quick glance, being influenced by what you thought it was going to say.



When it comes to thinking critically, just do it!
(*) Even if your teachers don't use critical thinking techniques in class, that doesn't mean YOU can't use them.
(*) During and after class, make sure you understand what is driving the concept, not just the points you have to remember
(*) Question the reason behind the information presented, for doing what you do
(*) and just remember that failure is OK, it get's us actually thinking about what when wrong and why. it's a regular part of the process, just make sure you use it to train your mind.



What's your answer to this question?

(*) How many of you were initially stumped because you thought of the beggar as a man? How much of that was influenced by your pre-conceived notations of what a beggar is, or the image I put up? This helps highlight how our what we are initially exposed to, and our pre-conceptions, thoughts, or opinions often drive our thought process.

Those pre-conceived thoughts can often influence our response to a question. For example, how do you think the average person would answer a question about where plants get their food?

(*) Perhaps something along the lines of “from the water, soil, and all over. This is because we are driven by our human centered concept of “food”.

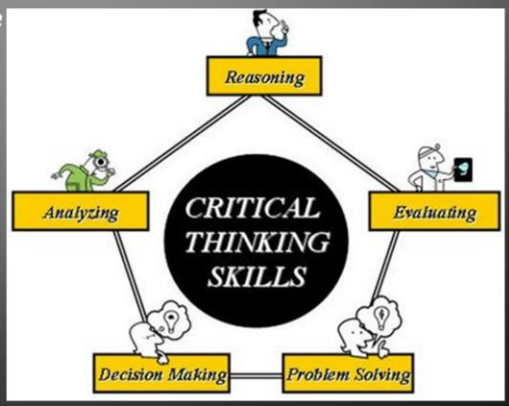
EXAMPLE: WHERE DO PLANTS GET THEIR FOOD?

- ~~From the water, soil, and all over~~
- They make their own food

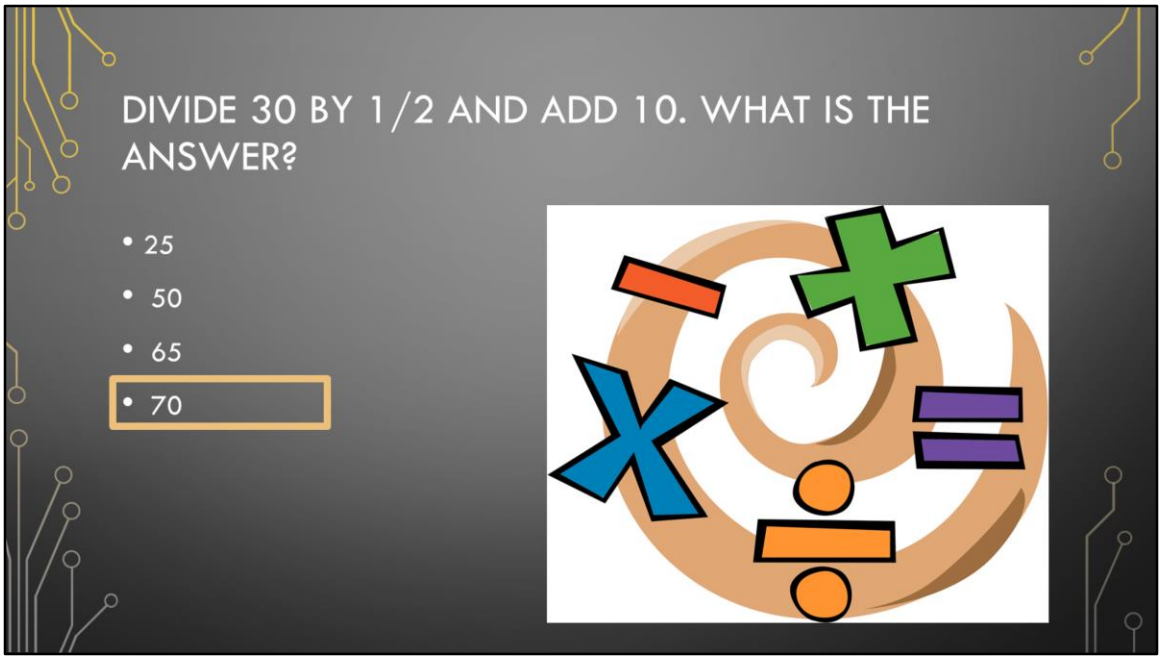
But, if we really think about it, the more appropriate response is that they make their own food. So, being aware of what our opinions are founded on is an important component to critical thinking.

CRITICAL THINKING – DO IT!

- What and why are you doing that?
- What will the results tell you?
- How important is that distinction?

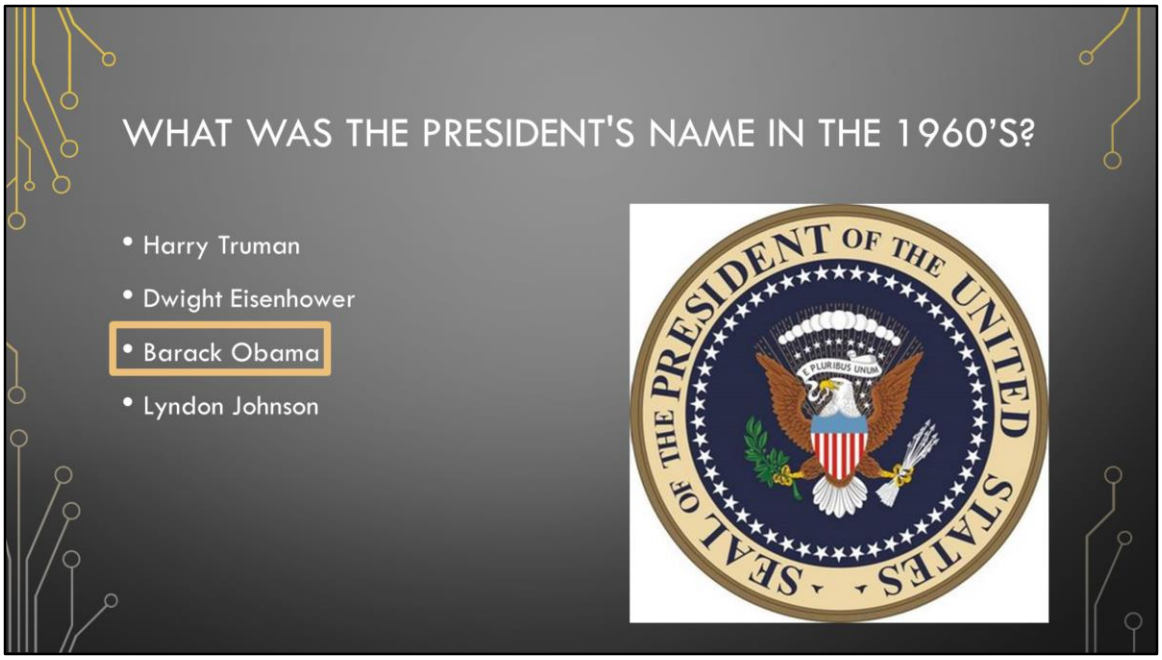


When thinking critically, make sure to ask yourself what and why you are doing things, what can the results tell you, and see if the minor details are important or not. The answer to these questions may change with every challenge.



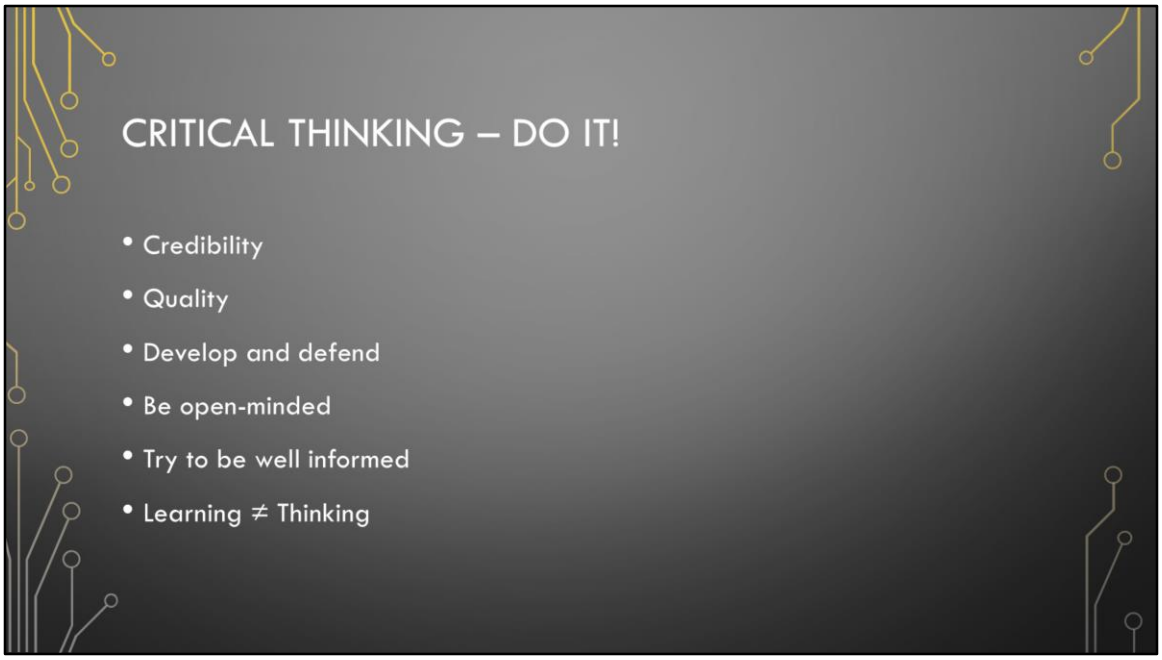
With regards to those minor details…

(*) 70. It does not say half of 30 but 30 divided by 0.5. Again, you can see how thing are worded is extremely important to our interpretation of a statement.



Ok, last one, at least for now.

(*) Even in a non-technical setting, your interpretation of a statement may influence the conclusions you draw. A huge goal of critical thinking is to be aware of how you perceive things, so that you can better assess the quality of the information presented to you.



In addition to paying close attention to what is actually said, remember, it's important to judge the credibility of the source

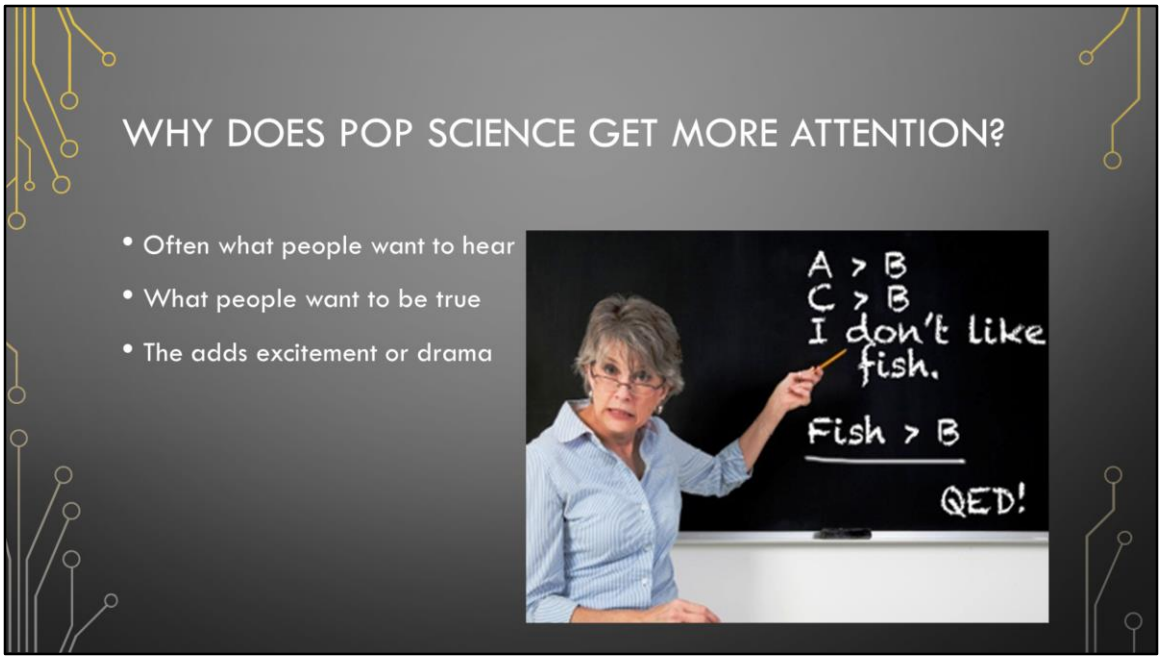
(*) Judge the quality of the arguments, including the reasoning, assumptions, and evidence presented.

(*) Develop your own position on the issue and make sure you can defend it.

(*) Keep an open mind, since new information my shift preconceived notions.

(*) And, be as well informed as is reasonable before taking a strong stance on an issue

(*) Lastly, just remember that just because you are learning something, doesn't mean you are thinking about it critically, you have to practice and make a conscious effort.



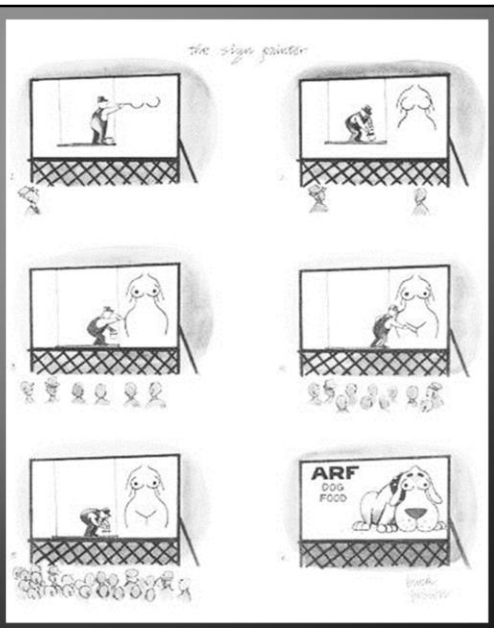
Let's put this into the practical setting of your ever day lives. Why do you think pop-science get more attention than "true" science?

(*) Take this image, for example. It could be what the woman wants to prove, thus she did, with no noticeable methods.
(*) another reason could be that it's what people want to be true.
(*) And lastly, pop-science puts an exciting spin on things that gets the media attention.

(side note, not for stating unless asked: Q.E.D. is an initialism of the Latin phrase quod erat demonstrandum, meaning "which had to be demonstrated". The phrase is traditionally placed in its abbreviated form at the end of a mathematical proof or philosophical argument when what was specified in the enunciation — and in the setting-out—has been exactly restated as the conclusion of the demonstration. The abbreviation thus signals the completion of the proof.)

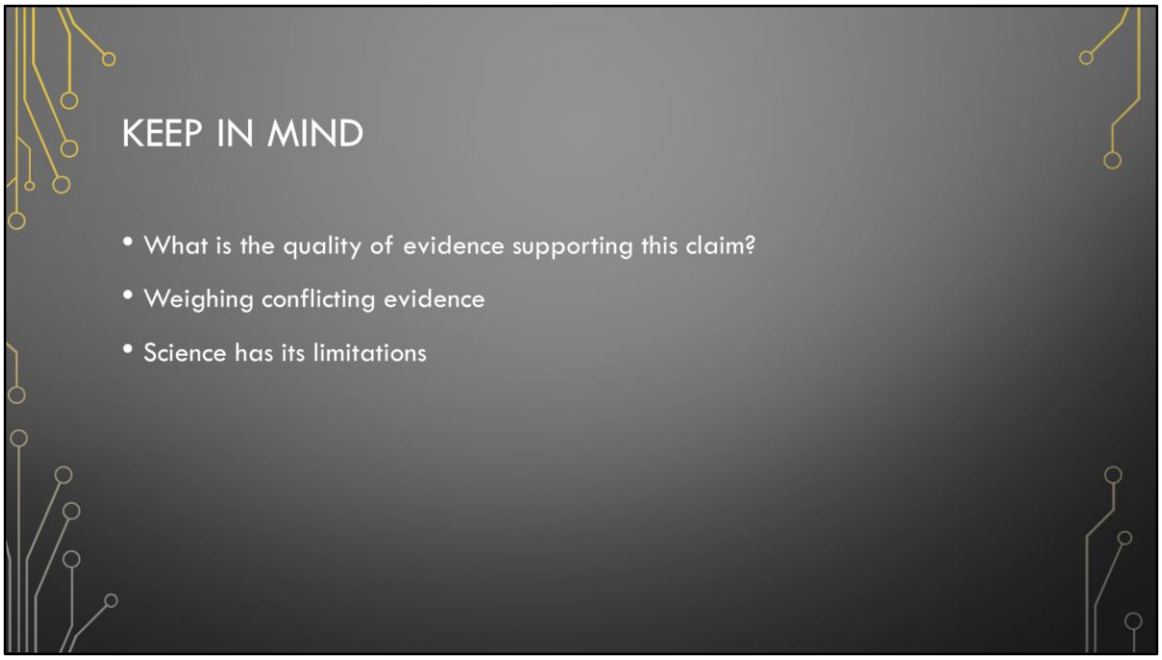
DON'T JUMP TO CONCLUSIONS!

- Example. Imagine a man and women are in an elevator having an argument. You enter the elevator to help get to your intended level within the building. During their argument you overhear them mention: 'the house' and 'the children' etc.

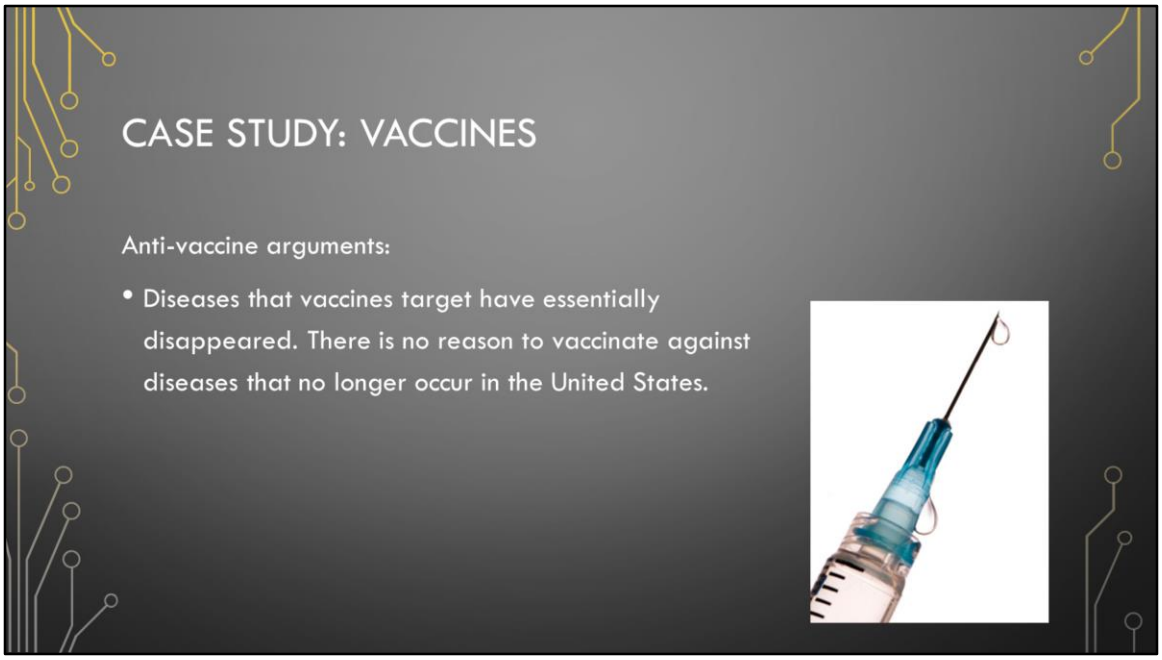


The main thing to remember is not to jump to conclusions.
(*) Take this example. (read). What is your initial conclusion on the relationship between the man and woman?

It would be perfectly natural from overhearing such statements to arrive at the conclusion that the people having the argument are husband and wife. However, the evidence does not directly support this and although such a conclusion may well appear natural and persuasive, these factors on their own do not make such conclusions correct. The couple could simply have been colleagues debating a newspaper story of a family, or even a family situation from a reality television program. Human reasoning often tries to fill in the blanks – and often does so by generating spurious conclusions to fit the incoming information. Sometimes the conclusion is correct, sometimes it is not. Due to the considerable scope for error in human reasoning scientists and philosophers have developed methods for reasoning about the world.



(*) What is the quality of the evidence supporting the claim? So look at how the outcome was measured, was there a control? What about the sample size, bias, reproducibility and plausibility?
(*) If you encounter conflicting evidence, look at the quality of evidence on each side and weigh it appropriately.
(*) Lastly, keep in mind that some things are not going to be answered by science. Science can not answer questions of religion or the supernatural since it is based on observations, repeated experiments, and evidence to support its conclusions.

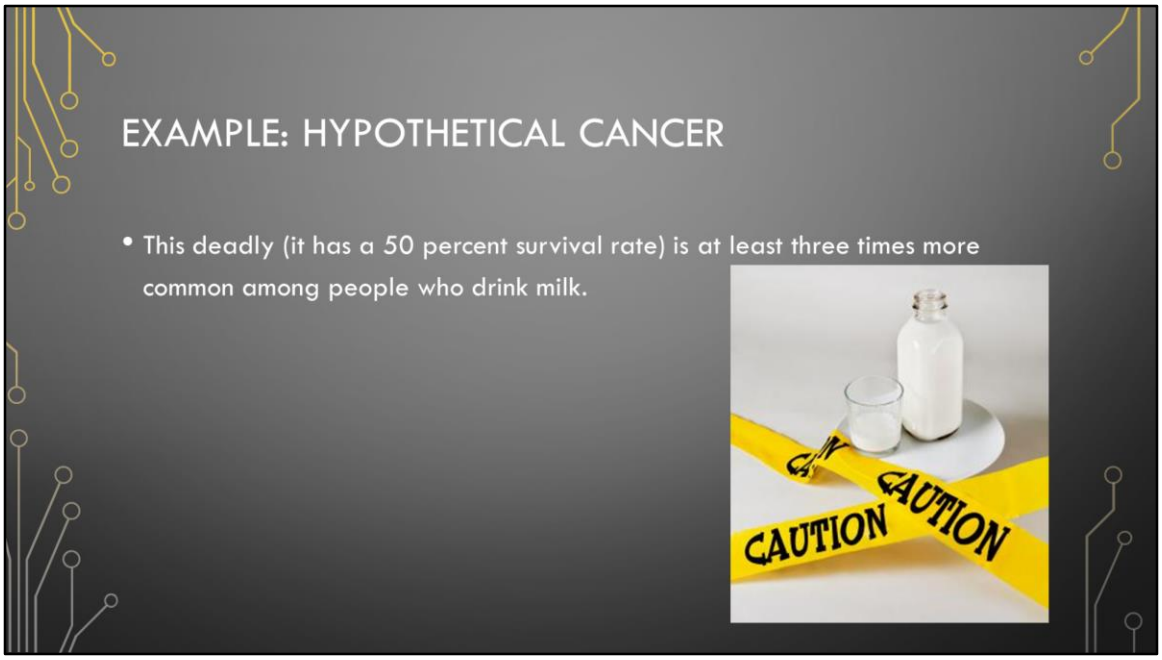


Alright, now that you know a bit more about how to train your mind and what to look out for, let's look at a few real-world examples. Take the public conflict over vaccinations, for example.

Reading these arguments, what are some of the critical thinking strategies you can use?

If proper research was done, the author of this statement would know that children are no longer vaccinated against smallpox or polio because the diseases no longer exists in the US due to vaccination. And, other diseases appear to be eradicated as a result of vaccinations, but are still present, and often have higher infection rates in other countries, thus vaccination is still necessary to prevent a re-emergence.

This highlights how information is selectively presented or misinterpreted. The training of the person making a claim is also extremely important to consider.



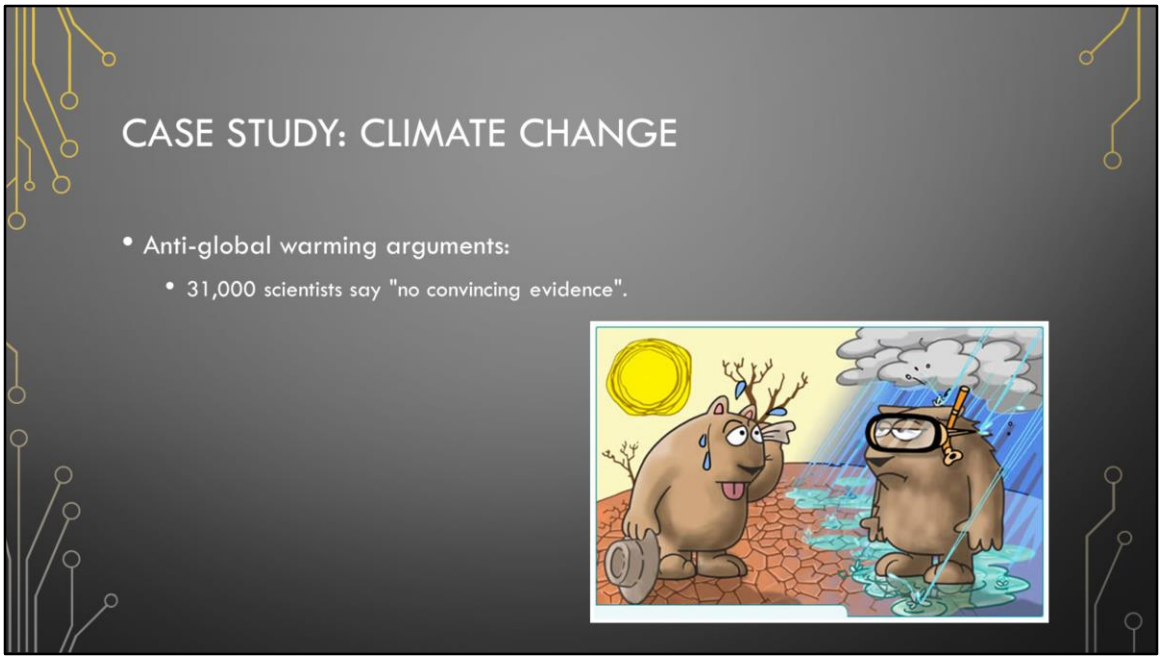
Based on this statement, would you avoid drinking milk? How much was your initial reaction in response to the staggering statistic?

So, thinking critically, what are some questions you should ask?

Now, what if I told you that it is extremely rare and occurs in less than 1 person in 100,000 and accounts for less than 1% of cancers in the US? Would you still avoid drinking milk, at least for this reason?

I use this example to highlight the importance of watching out with statistics and emphasizing the power of imagery and how it can be used as a scare tactic or used to convening a biased opinion. Taken alone, some numbers seem very astounding. 3 times more common, wow! But, when you look at the bigger picture, avoiding milk decreases your overall chances of getting this hypothetical cancer by 0.75%. Just make sure to question what the statistics are actually saying, and use caution when making firm opinions based on images.

How much was your initial reaction in response to the initial statistic? After hearing the actual occurrence, did your opinion change?



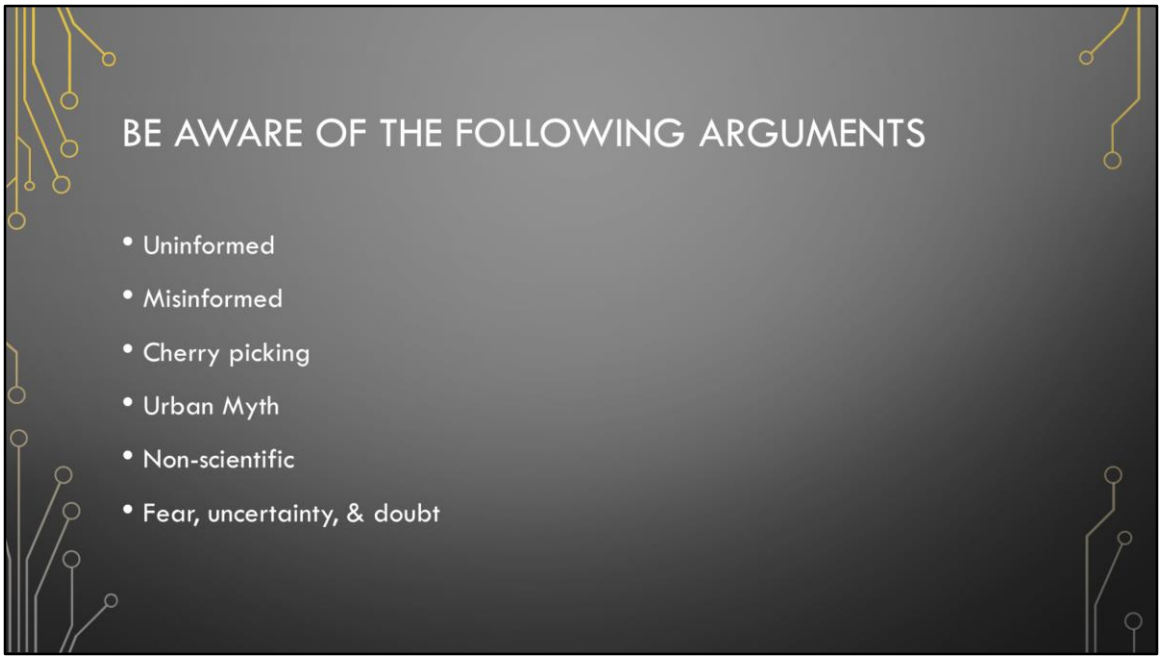
Ok, let's try another example. Let's talk a bit about climate change. An argument against it is that "31,000 scientists say "no convincing evidence".

So, what is your next move? What are questions you might ask?

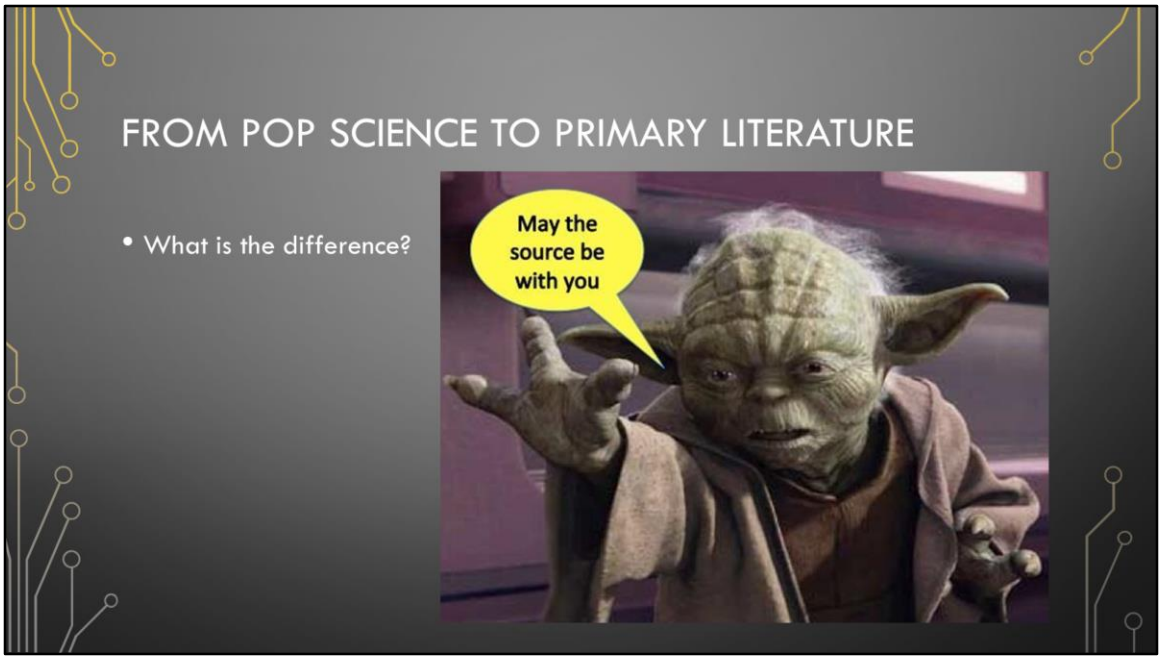
The statement comes from an online petition and check a box that said stated your degree. The results are not verifiable. Also, area of study included engineers, medicine, chemistry, biology, etc. Not many of whom study climate science.

This report also failed to mention that of scientists working in the field of climate science, and publishing papers on the topic, 97% of the climate scientists surveyed believe "global average temperatures have increased" during the past century; and 97% think human activity is a significant contributing factor in changing mean global temperatures.

Again, pay attention to the original source of statistics, and even then, look at what they are REALLY saying.



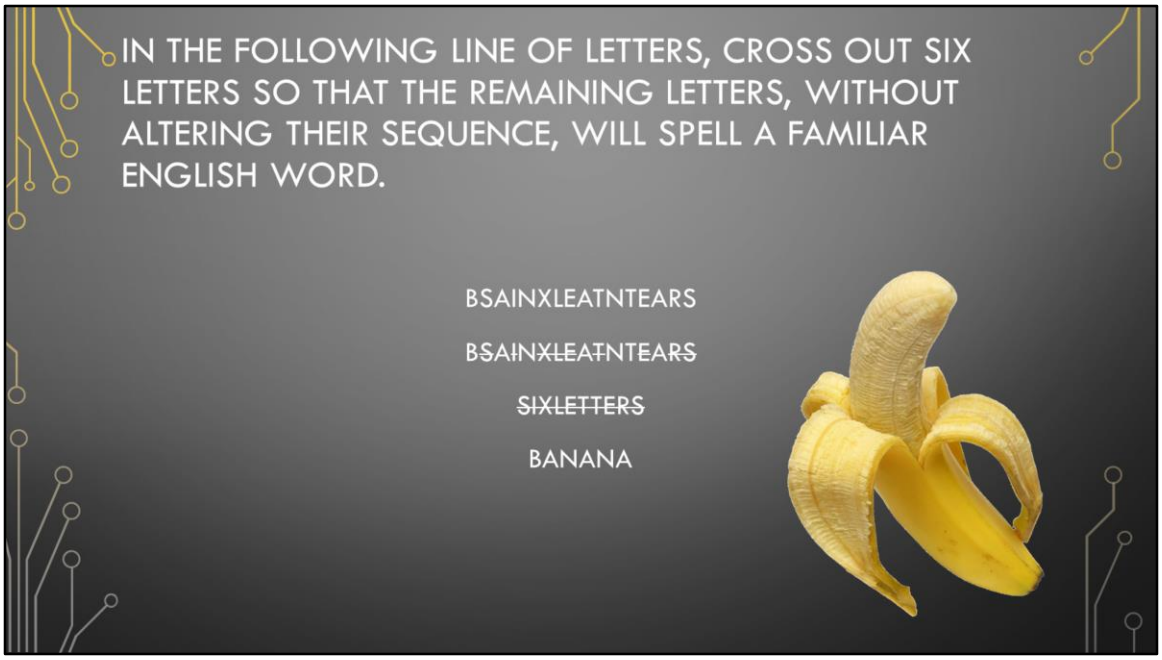
Pop-science and media-coverage of hot topics are often biased, depending on who is presenting the information. Many of the arguments are uninformed, misinformed, cherry picked to fit their personal agenda, stem from urban myths, have no scientific basis, or come from fear, uncertainty and doubt.



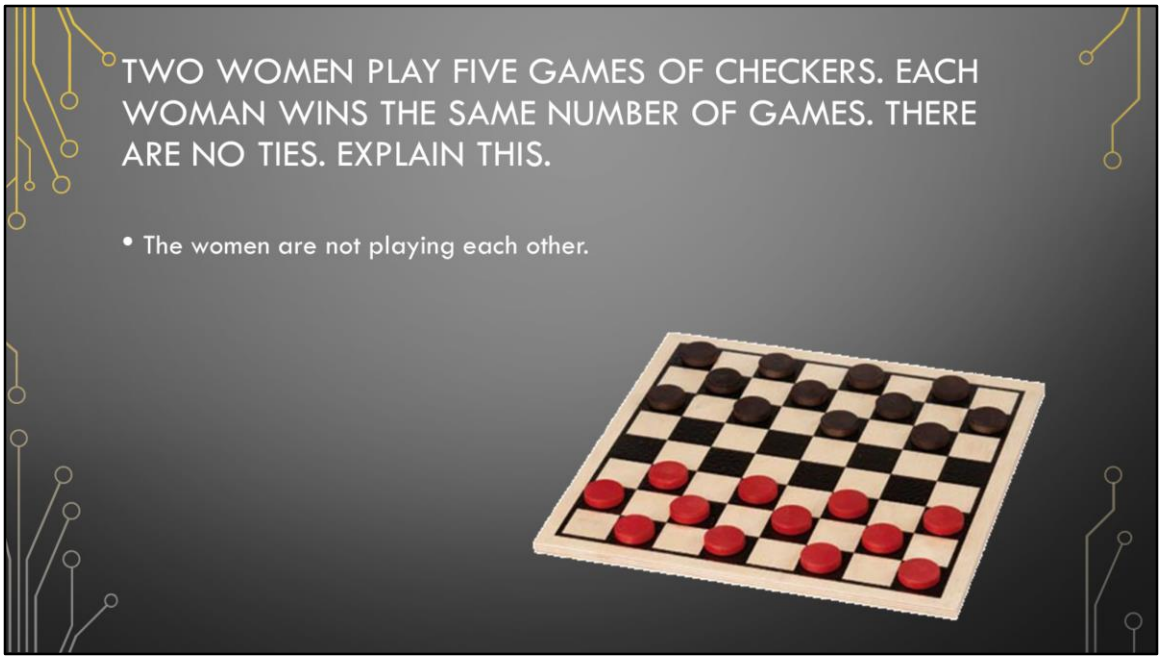
The case studies were from of pop science sources. How do these differ from primary literature? We briefly went over this, but lets discuss in a bit more detail.
(Discussion)
Regardless of what type of information you are reading, make sure you are paying attention to your thought process, metacognition, and critically thinking about what information is presented to you, even in reliable scientific journals.

The main thing to keep in mind is that there should be an original source for the information. If it is primary literature, you should find it and read it for yourself. Pay attention to where it was published and use these newly acquired skills when reading the original source. Although primary literature is peer-reviewed, that does not mean it is infallible.

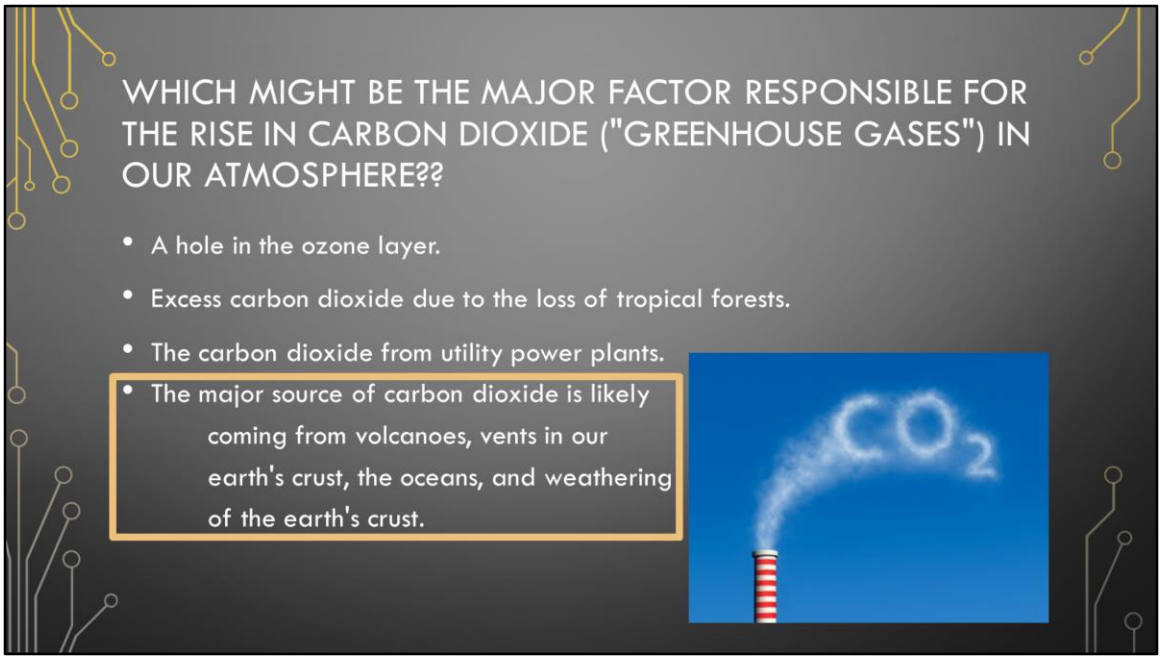
Now that your mind is warmed up, let's end with a few more questions.



(read slide, give them time, show the answer) When given a set of directions, you must choose how to interpret them. This is similar to when you are presented with data or an argument, that claims to be founded in evidence.



(read slide, give them time, show the answer)
(*) Who was tricked by the wording and initially thought they were playing each other?



Ok, last one, (read slide, give them time, show the answer) Did you learn from your mistakes before or did you let this image influence your decision?

(*) A recent report showed that the mud vents in Yellowstone Park put out more carbon dioxide than a mid-sized power plant! This is not to say that deforestation is not part of the problem, but it is sort of ironic to find out that a pristine wilderness area is such a major source of carbon dioxide and other "greenhouse gases".

Think of what this means. How does it relate to the previous question about climate change, and the ideas about numbers and statistics?

Although most CO2 comes from natural sources, no climate scientist is arguing that this is the cause of climate change, but it's the additional input by humans that is the issue, the straw that broke the camels back, per say.

QUESTIONS?

SURVEY

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