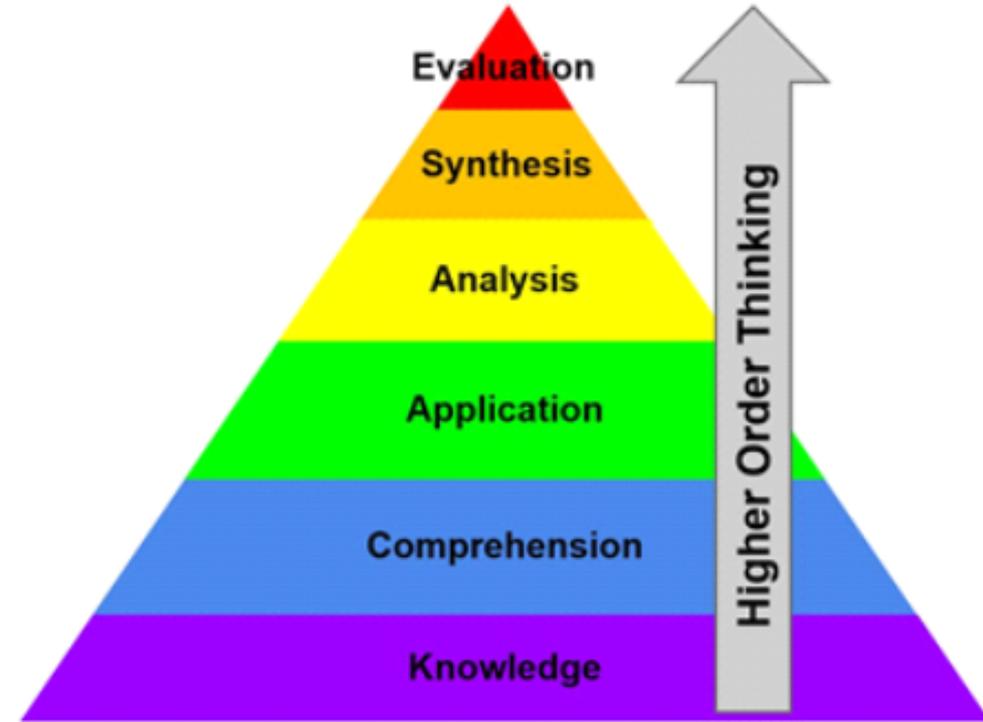


# Critical Thinking

“The careful, deliberate determination of whether one should accept, reject, or suspend judgment about a claim and the degree of confidence with which one accepts or rejects it.”

*(Critical Thinking. B. Moore and R. Parker, 2007)*

What are examples of higher order thinking?

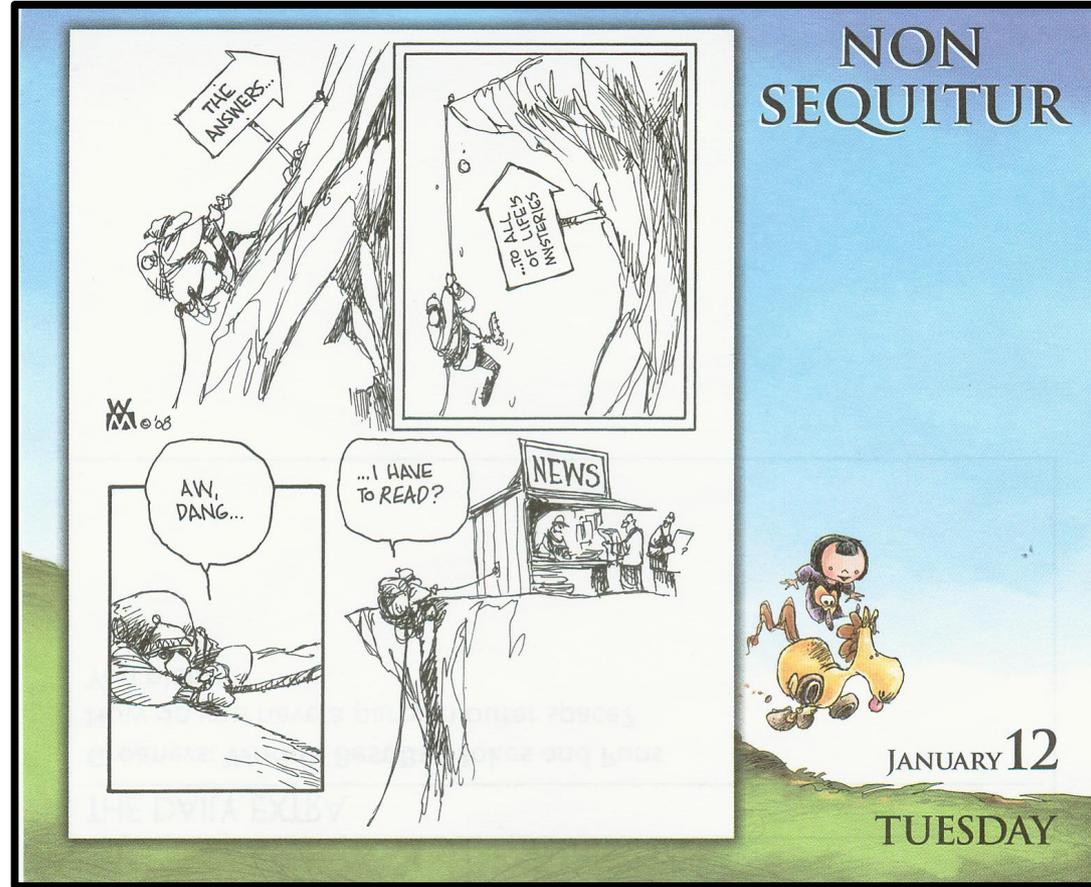


Bloom's Taxonomy  
Cognitive Domain

# Examples of using Critical Thinking

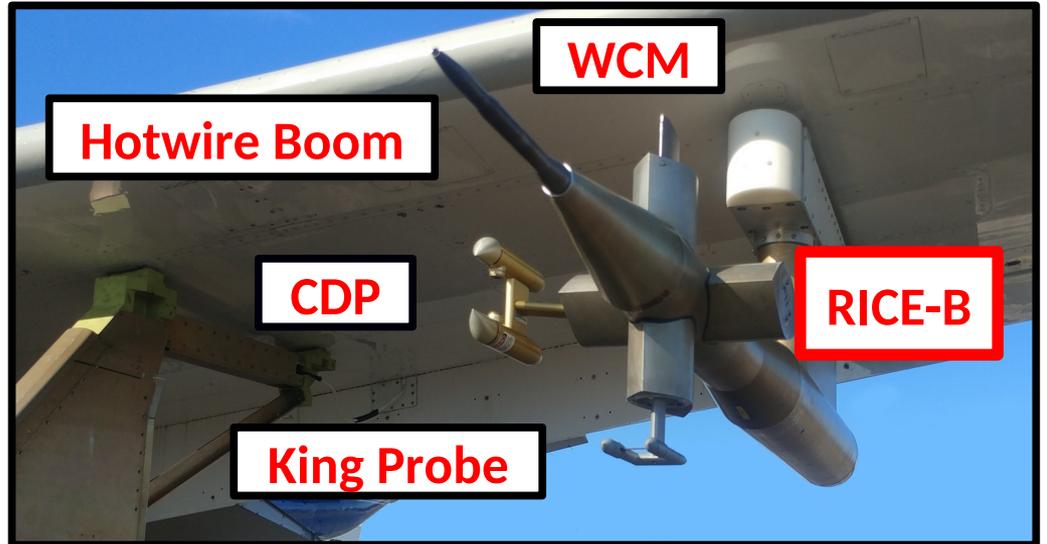
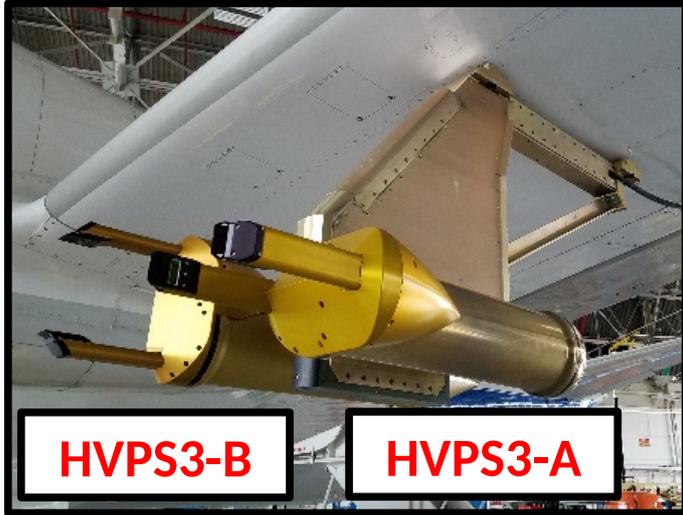
- Approaching Questions
- Solving Problems
- Taking Action

Requires active thinking, the use of reason, and an open mind.



What is an example of how you used critical thinking?

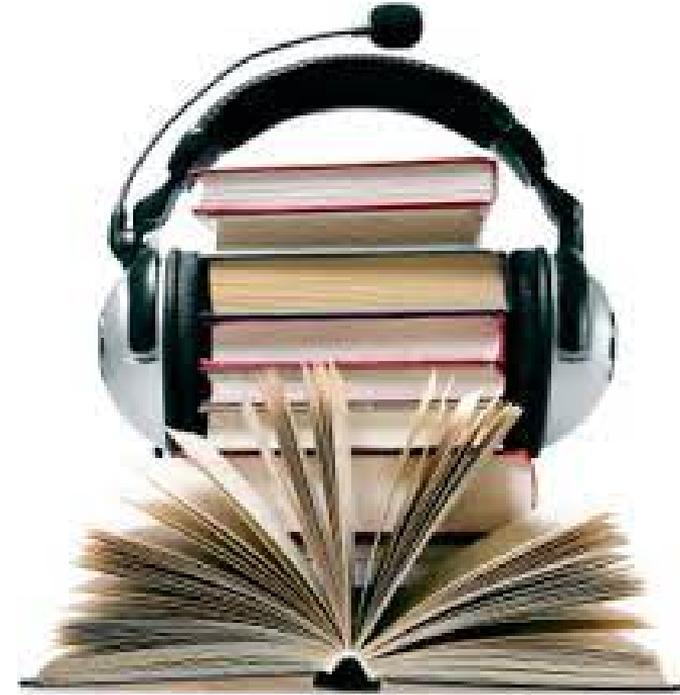
# As we Discuss Critical Thinking: How Does it Apply?



# Application of Critical Thinking

Critical thinking should be applied to:

- Expressing your own thoughts, beliefs, and opinions.
- Reading or listening to the thoughts, beliefs, opinions of others.



How can you apply critical thinking to class lectures?

# Elements of Thought and Reasoning

- It has a purpose.
- It is trying to figure something out.
- It is based on assumptions.
- It is done from some point of view.
- It is based on information.
- It is expressed through concepts & theories.
- It contains interpretation of data and observations.
- It has implications and consequences.

Periodic Table of the Elements

Legend:

- State of matter (color of name): GAS, LIQUID, SOLID, UNKNOWN
- Subcategory in the metal-metalloid-nonmetal trend (color of background): Alkali metals, Alkaline earth metals, Transition metals, Post-transition metals, Lanthanides, Actinides, Metalloids, Reactive nonmetals, Noble gases, Unknown chemical properties

1 IA	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA	
H Hydrogen 1.008	He Helium 4.0026											B Boron 10.811	C Carbon 12.011	N Nitrogen 14.007	O Oxygen 15.999	F Fluorine 18.998	Ne Neon 20.180	
Li Lithium 6.941	Be Beryllium 9.0122											Al Aluminum 26.982	Si Silicon 28.086	P Phosphorus 30.974	S Sulfur 32.06	Cl Chlorine 35.45	Ar Argon 39.948	
Na Sodium 22.990	Mg Magnesium 24.305	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIB	9 VIIB	10 VIIIB	11 IB	12 IIB	Zn Zinc 65.38	Ga Gallium 69.723	Ge Germanium 72.630	As Arsenic 74.922	Se Selenium 78.96	Br Bromine 79.904	Kr Krypton 83.798
K Potassium 39.098	Ca Calcium 40.078	Sc Scandium 44.956	Ti Titanium 47.88	V Vanadium 50.942	Cr Chromium 52.00	Mn Manganese 54.938	Fe Iron 55.845	Co Cobalt 58.933	Ni Nickel 58.693	Cu Copper 63.546	Zn Zinc 65.38	Ga Gallium 69.723	Ge Germanium 72.630	As Arsenic 74.922	Se Selenium 78.96	Br Bromine 79.904	Kr Krypton 83.798	
Rb Rubidium 85.468	Sr Strontium 87.62	Y Yttrium 88.906	Zr Zirconium 91.224	Nb Niobium 92.906	Mo Molybdenum 95.94	Tc Technetium 98.906	Ru Ruthenium 101.07	Rh Rhodium 102.905	Pd Palladium 106.42	Ag Silver 107.868	Cd Cadmium 112.411	In Indium 114.818	Sn Tin 118.710	Sb Antimony 121.757	Te Tellurium 127.60	I Iodine 126.905	Xe Xenon 131.29	
Cs Cesium 132.905	Ba Barium 137.327	55-71 Lanthanides	Hf Hafnium 178.49	Ta Tantalum 180.948	W Tungsten 183.84	Re Rhenium 186.207	Os Osmium 190.23	Ir Iridium 192.22	Pt Platinum 195.084	Au Gold 196.967	Hg Mercury 200.59	Tl Thallium 204.38	Pb Lead 207.2	Bi Bismuth 208.980	Po Polonium 209	At Astatine 210	Rn Radon 222	
Fr Francium 223	Ra Radium 226	89-103 Actinides	Rf Rutherfordium 261	Db Dubnium 262	Sg Seaborgium 263	Bh Bohrium 264	Hs Hassium 265	Mt Meitnerium 266	Ds Darmstadtium 267	Rg Roentgenium 268	Cn Copernicium 269	Nh Nihonium 270	Fl Flerovium 271	Mc Moscovium 272	Lv Livermorium 273	Ts Tennessine 274	Og Oganesson 276	
Lanthanides and Actinides																		
La Lanthanum 138.905	Ce Cerium 140.12	Pr Praseodymium 140.908	Nd Neodymium 144.24	Pm Promethium 144.913	Sm Samarium 150.36	Eu Europium 151.964	Gd Gadolinium 157.25	Tb Terbium 158.925	Dy Dysprosium 162.50	Ho Holmium 164.930	Er Erbium 167.259	Tm Thulium 168.930	Yb Ytterbium 173.054	Lu Lutetium 174.967				
Ac Actinium 227	Th Thorium 232.038	Pa Protactinium 231.036	U Uranium 238.029	Np Neptunium 237.048	Pu Plutonium 244.064	Am Americium 243.061	Cm Curium 247.070	Bk Berkelium 247.070	Cf Californium 251.080	Es Einsteinium 252.083	Fm Fermium 257.103	Md Mendelevium 258.106	No Nobelium 259.108	Lr Lawrencium 262.109				

# Questions Using Elements of Thought

- Purpose
  - What am I trying to accomplish?
- Questions
  - What question am I raising or addressing?
  - Am I considering the complexities?
- Information
  - What information or experience am I using?
  - What information do I need?
- Inferences/Conclusions
  - How did I reach this conclusion?
  - Is there another interpretation?



# Questions Using Elements of Thought

- Concepts
  - What is the main idea?
  - Can I explain it?
- Assumptions
  - What am I taking for granted?
  - What have I assumed?
- Implications/Consequences
  - What am I implying?
- Points of View
  - What point of view am I using?
  - Is there another point of view to consider?



# Intellectual Standards

- Clarity – Further elaboration, examples
- Accuracy – Verify, check out
- Precision – More specific, further details
- Relevance – Relate to question
- Depth – Complexities and difficulties
- Breadth – Another perspective, other point of view
- Logic – Makes sense, conclusions follow evidence
- Significance – Central idea, most important facts
- Fairness – Vested interest in the issue



# Standards and Elements

- Intellectual Standards should be applied to Elements of Thought.
- This approach can be used to:
  - Analyze contents of an article.
  - Analyze and assess research.
  - Help you formulate your own conclusions.
  - Help you take a reasoned stand on an issue.
- This leads to developing Intellectual Traits.



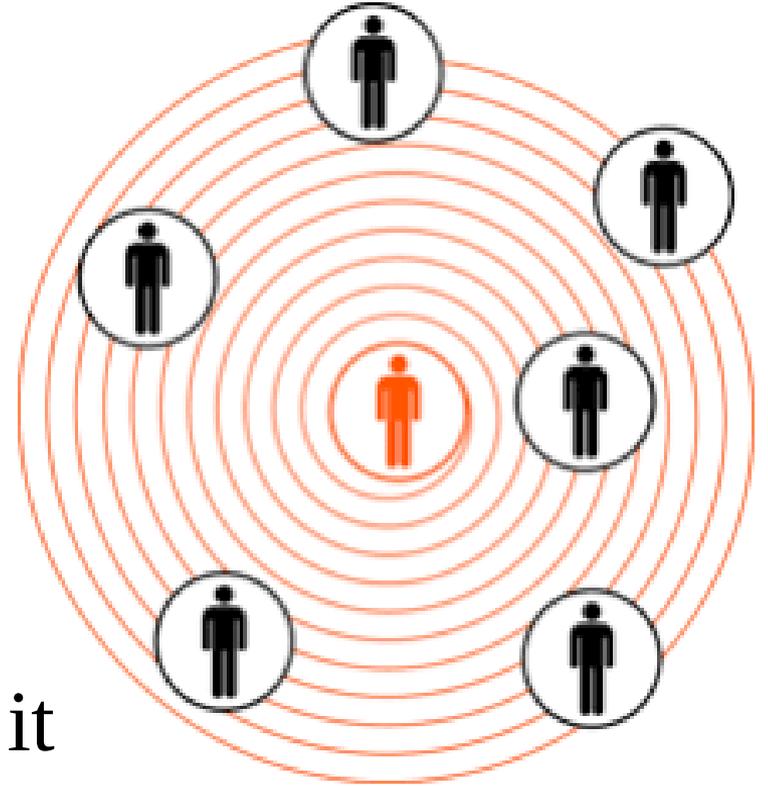
# Intellectual Traits

- Intellectual Humility - Realize limits of own knowledge
- Intellectual Courage - Ideas/beliefs/views that counter our own
- Intellectual Empathy - See the other side
- Intellectual Autonomy - Think for yourself
- Intellectual Integrity - Hold yourself to consistent, high standards
- Intellectual Perseverance - Work through confusion
- Confidence in Reason - Believe that high standards will win out
- Fair-mindedness - Treat all viewpoints alike

# Egocentric Thinking

It's true because:

- I believe it
- We believe it
- I want to believe it
- I have always believed it
- It is in my own interest to believe it



# Apply Critical Thinking to Weather Modification

- Approaching Questions
- Solving Problems
- Taking Action

Requires active thinking, the use of reason, and an open mind.



Image from cloud seeding in North Dakota on July 2, 2012. Credit: David Delene