

Questions To Ask

Thinking About the Nature of the Embedded Causality to Assess What Makes Understanding Difficult

Questions:	Notes:
Obviousness/Concreteness of the Variables:	
1. Are there important variables that are non-obvious or hard to detect? (ex: air pressure, gases)	
2. Are there important variables that students are likely to take for granted? (ex: the liquid in sinking and floating)	
3. Are there variables that are inferred, or constructed as part of the currently accepted explanation, but not necessarily accessible? (ex: electrons, protons, etc.)	
4. Are there important variables that play a passive role? (ex: protons)	
5. Are there causes that are spatially far away from their effects or vice versa? (ex: the forces that cause satellites to orbit, how Hurricane Katrina affected gas prices nationally.)	
6. Are there time delays or gaps between causes and effects? (ex: eating of infected beef and onset of Mad Cow Disease.)	
7. Are there preconditions that are not necessarily part of the causal story, but are related to it in some way? (ex: Lightning typically occurs when there are temperature differentials.)	

Location/Coordination of the Causes or Agents:	
8. Are there contributing causes in many places (as compared to a cause in a central place)? (ex: the actions of the many individual voters or bloggers as compared to a president's decision.)	
9. If yes to Question 8, are those actions/intents uncoordinated as compared to coordinated? (ex: a lot of people driving cars contributing to global warming or individual actions that result in wide scale civil unrest vs. voting for a president.)	
Interaction between Causes and Effects:	
10. Is the effect different in size/magnitude than the cause? (ex: repeated cause and no obvious effect until there is a very large effect (as in the point where the environment can no longer accommodate pollution; as in tipping point phenomena), smallish causes that precipitate complex interactions until there is a big outcome such as the accident at the Chernobyl Nuclear Power Plant.)	
11. Do the causes or effects add up or interact with each other? (ex: accumulation or where one set of effects amplifies another set of effects, etc., accumulation of pollution, greenhouse gases.)	
12. Are there multiple possible causes where any of the causes is enough to get the effect? (ex: application of heat or pressure are each sufficient to make something boil.)	
13. Are there multiple causes where causes work together to make something happen (and you need all of them)? (ex: certain chemicals for a chemical reaction to occur.)	

Causal Pattern:	
14. Are there indirect effects? (ex. the loss of green plants on carnivores)	
15. Are there non-linear cause and effect relationships? (ex. as in home heating systems, etc.)	
16. Are there bi-directional effects or causes? (ex. as in symbiotic relationships)	
17. Are there causes that impact the effect of another cause (mediate it, a catalyst or a barrier)? (ex: Insulation mediates the process of thermal equilibrium.)	
18. Are there multiple causes or multiple effects? (ex: an oil spill affects birds, sea life, cleanliness of beaches, fishing industry)	
19. Can you make predictions about the causal system by reasoning about its constraints? (ex: reasoning from Ohm's Law)	
Contiguity:	
20. How much consistency is there between the cause and the effect? Does it always happen, some of the time, etc.? (ex: Deterministic causality where every cause is followed by an effect vs. probabilistic causality where the outcome happens some of the time in response to the cause but not consistently.)	
21. Is there noise that makes it hard to see the relationship between causes and effects? (ex. seasonal effects and other periodic changes in detecting global warming)	

Levels:	
22. Is there order at one level and not at another? (ex: the gas laws where disorder at one level is orderly at another)	
23. Do you need to understand the concepts at more than one level to understand what is going on? (ex. Understanding a circuit at the level of the individual electrons and protons vs. at the level of the system). If so, what is the relationship between the levels? Are there different sets of variables or causal patterns at different levels?	