

Causal Complexity: Questions to Ask 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 posited entities, asserted as part of the currently accepted model, but not necessarily accessible? (Ex. electrons, protons, etc.)	
4. Are there important variables that play a passive role? (Ex. protons in circuits)	
5. Are there causes that are spatially far away from their effects or vice versa? (Ex. the forces that cause satellites to orbit, Hurricane Katrina affects gas prices nationally.)	
6. Are there time delays or gaps between cause and effects? (Ex. eating of infected beef and onset of Mad Cow Disease.)	

<p>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 during temperature changes or when there are temperature differentials.)</p>	
<p>Location of the Causes or Agents:</p>	
<p>8. Is the cause in one central place or are there contributing causes in many different places? (Ex. a president's decision versus the actions of the many individual voters, bloggers.) Are those actions/intents coordinated or uncoordinated? (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)</p>	
<p>Interaction between Causes and Effects:</p>	
<p>9. Are there patterns where the effect is not the same size as 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, Chernobyl)</p>	
<p>10. Do the causes or effects add up or interact with each other? (Ex: cumulative or where one set of effects amplifies another set of effects, etc., accumulation of pollution, greenhouse gases.)</p>	



<p>11. 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.)</p>	
<p>12. Are there multiple causes where causes work together to make something happen (you need all of them)? (Ex. You need certain sets of chemicals for a chemical reaction to occur.)</p>	
<p>Causal Pattern:</p>	
<p>13. Are there indirect effects? (Ex. the loss of green plants on carnivores)</p>	
<p>14. Are there non-linear cause and effect relationships? (Ex. as in home heating systems, etc.)</p>	
<p>15. Are there bi-directional effects or causes? (ex. as in symbiotic relationships)</p>	
<p>16. 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)</p>	
<p>17. Are there multiple causes or multiple effects? (Ex. an oil spill affects birds, sea life, cleanliness of beaches, fishing industry)</p>	

<p>18. Can you make predictions about the causal system by reasoning about its constraints? (Ex. reasoning from Ohm's Law)</p>	
<p>Contiguity:</p>	
<p>19. 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, you roll the die and the effect of getting a six happens some of the time)</p>	
<p>20. Is there noise that makes it hard to see the relationship between causes and effects? (Ex. seasonal effects in detecting global warming)</p>	
<p>Levels:</p>	
<p>21. Is there order at one level and not at another? (Ex. the gas laws where disorder at one level is orderly at another)</p>	
<p>22. 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 forms?</p>	