Causal Patterns in Science
a professional development resource

Diagnosing When You Need a RECAST Activity

Ecosystems

Think about the source of the students' difficulties. Ask yourself, "Does it have to do with causal structure or other factors?" Here are some possibilities:

In these cases, you do NOT need a RECAST Activity:

Misinformation or misunderstanding NOT related to causality:
Some confusions or misunderstandings are not related to causality.

Examples:

- Thinking that the food web refers to individuals rather than populations of animals.
- Thinking only in terms of individual organisms people keep that need humans for their survival, such as pets, zoo animals, or houseplants.
- Thinking that organic matter cannot change to mineral matter during decay because one maintains a strong separation between living and non-living things.

Cognitive challenges NOT related to causality:
Some concepts give students difficulty due to the nature of the thinking challenge.

Examples:

- Trying to hold information in your head such as coordinating what the rabbit population will be given a certain size fox population.
- Visualizing information that is dynamic, and/or includes more than one variable, such as how temperature and moisture affect the rate of decay.

In these cases, you DO need a RECAST Activity:

A simpler causal structure is substituted for a more complex one:
The student has reduced the phenomenon to a simpler causal structure than the scientifically accepted explanation.

Examples:

- Attending only to direct effects and missing indirect ones, such as thinking that if all of the green plants disappeared, it would affect the primary consumers but not the secondary consumers.
- Focusing on only one half of a symbiotic relationship (for example, flowers help bees by providing food, but not seeing that bees help flowers by pollinating them.)
- In a simple linear way, assuming an event is predetermined in order to fill a need. For example, saying, "There are a lot of rabbits so that foxes will not get hungry". Or "plants make food for the benefit of animals and people rather than for plants themselves."

Missing information or misunderstanding a fact that is related to causality:
Misinterpreting a concept related to causality such that it reinforces simplistic models.

Examples:

- Even when students have been taught photosynthesis, they still believe that plants obtain some of their food from the environment (so they miss the critical importance of the domino model that starts with the sun.)
- When reasoning about balance and flux in ecosystems, students typically reason that flux is bad and only balance is good. This can make it difficult to detect the role of flux in positive outcomes.

RECAST Activity Required Continued

Non-obvious variable(s) contribute to a simpler model:
There are non-obvious variables that the student fails to notice and so he/she applies a simpler causal model.

Examples:

- Missing the underlying processes in a food web, such as energy transfer, cycles of matter, and interdependency, thus focusing on simple direct effects or food chains.
- Thinking that the arrows in a food web go from the organism that is doing the eating to the organism that is being eaten instead of vice versa (because students focus on the action of eating rather than the passive process of energy flow.)
- Not recognizing photosynthesis as the process by which energy from the environment becomes available to the entire food web (so missing the critical domino model involved).
- Not realizing that matter is conserved when thinking about decomposition or that material from dead organisms becomes part of the nonliving environment such that they miss the cyclic pattern of the matter cycle.
- Not recognizing the role of tiny microbes as the primary decomposers of matter so thinking that matter "breaks down by itself."
- Because of the time delay involved in nutrient recycling, thinking that the nutrients are lost to the food web or that they disappear.

Confusing two processes and applying the wrong causal model to each:
Students may apply a causal model from one concept to another where it doesn't fit.

Example:

- Students confuse the processes of energy transfer with the process of matter recycling. They think that energy from the sun is recycled following a cyclic causality instead of domino causality.

Not recognizing multiple possible causes:
Being efficient in searching out causes and stopping after finding one when there may be multiple possible causes, any one of which is sufficient for causing the outcome or two or more causes might work together.

Examples:

- Students think that worms are responsible for all of the decomposition when there are multiple decomposers. Microbes, worms, and other decomposers all cause the process of decomposition.
- Changes in population can be due to multiple factors such as the introduction of new species, decline in food sources, and/or disease, not just one event. (But often it is easier to attribute it to one event.)
- In an ecosystem, organisms fill overlapping roles and can often fill more than one niche. For this reason, if a population declines or disappears, it may not be noticeable. This leads to a certain amount of stability and insurance in the ecosystem, but can also lead to tipping point phenomena if there is enough change in populations filling the same niche.

Not recognizing the multiple levels at which causes and effects can be analyzed:
Students easily confuse the multiple levels of causes and effects in an ecosystem.

Examples:

- Even when students accept that populations in a food chain are related, they may still see predations as a "specific eating event" for the benefit of the eater alone.
- Students tend to regard food which is eaten and used for energy as belonging to a food chain. Food which is incorporated into the body material of eaters is seen as something different and it is not recognized as the material which is the food of the next level.