Vehicles for fostering thinking/learning:

- ✓ Refutations

Refutation example #1

SED SC511 Science Teaching Methods

Refute…

1. Formulating “instructional theories” for teaching science sounds good on paper, but in reality, there is little time for theories in actual classroom teaching. Rather than embark on directions that may only frustrate you because of time and student body limitations, the realistic approach is to simply be well prepared to deliver the content required and be flexible as to how much the student can take in and that each student is different.

Refutation example #2

SED SC511 Science teaching methods

2. In science teaching preparation, there is no substitute for experience. Indeed, it seems to me that foregoing the preparatory methods courses and simply getting into the classroom immediately as a student would be preferable. The time spent wading through academic class exercises and readings would be better spent by getting into the high school or middle school classroom on day one and begin sharing your knowledge of the subject matter. The fact is you KNOW more in most cases on the subject matter than your students would.

Refutation example #3

CAS Bi117 Global Ecology

Refute concisely and clearly.

1. The fragmenting of habitats, when accomplished within reason, will actually increase biodiversity. For example, the edge effects that occur by a new interface between a forested area and a developed or agricultural area create new new niches that were not substantially in the area previously. (50)

2. Increased global warming due to higher amounts of carbon dioxide in the atmosphere may actually enhance crop growths and natural ecosystems. If there is more carbon dioxide, it would follow that plants, perhaps with some added fertilizer, would grow faster and larger. If this rate of leaf and root and wood production increases, all of this carbon in the plant would eventually through decomposition be added to the soil. More carbon would accumulate there and this would offset continued atmospheric carbon dioxide emissions as well as have much higher crop and forestry yields. (50)

Vehicles for fostering thinking/learning:

- ✓ Case history analysis

Case studies analysis #1
CAS Bi117 Global Ecology

A South Pacific is land has had a relatively stable native parrot population over the past 60-70 years. Populations of the birds peak during some years (1) and drop off (2) and then re-peak again (3) repeatedly during these decades.

During this same period, previously domestic cat varieties were prevalent on the island (4), yet, populations of the these birds never dropped below ecological fitness (5). More suddenly, in the past twenty years, the rabbit was introduced to the island by settlers.

This introduction coincided with the increase of edge effect diameters (6) due to fragmented vegetation clearing for farming. Recent studies indicate that the even though the parrots are not attacked and eaten by the rabbits of course, the parrot population has dropped dramatically. (7)

Case history analysis #2

CAS Bi503 Symbiosis

Explain at each of the numbers. Speculations based on sound reasoning, knowledge are welcome…

Human mis-use of a five square mile land mass with a maximum fifteen degree slope in the rainforest region of the northwest isle of Kauai in the Hawaiian island chain has resulted in a denuded area. Most of the larger vegetation was removed and an unsubstantiated number of cycles of agricultural growth, dormancy, substantial N-P-K fertilization, and then re-planting had occurred previously.

After extensive investigations based largely on soil samples, a research team discovers a dramatic reduction of mycorrhizal fungi in the soil. They -- erroneously in this case -- believe that the removal of the vegetation was the primary cause for much of the mycorrhizae biomass disappearance, which often are attached to the removed plant debris and get washed away after the vegetation removal. (1)

In an at tempt to bring back at least some semblance of p revious natural vegetation back, they initiate an effort to infect the area with spores of southern hemisphere vesicular-arbuscular mycorrhizae. Despite favorable weather conditions, there is little evidence of vegetation re-growth.(2) After a heavy rainy period, they then plant healthy seedlings of many of the original plants from that rainforest region which had been carefully grown and maintained in a greenhouse setting. They also took mycorrhizae, which they had found in that greenhouse soil, and placed its mycelia and spores into the denuded landscape en masse.

After a full growing season, there was still no significant re-growth of the vegetation.(3) This was confusing because after moist periods, there were now a good deal of mushroom fruiting bodies scattered about.(4) They did not notice a significant increase in plant growth and corresponding levels of mycorrhizae until a year later -- after they planted several locust and soy species (5). Despite the renewed growth of the original plants, microscopic studies of the root apex of many of the plants show no mycorrhizal infected cells even after many weeks of growth!(6)

Case history analysis #3: Coral dinoflagellate symbiosis

CAS Bi503 Symbiosis

At each of the numbers, examine the previous statement(s) and offer a coherent scientific-based explanation(s) or speculation. Be sure to discuss with your partner.

Researchers studying coral reefs off the Belize coast, among the US and British Virgin Isles and in parts of the Great Barrier Reef off northern Australia have repeatedly verified previous anecdotal evidence from recreational divers that there is a "whitening" or bleaching of living reefs which, in turn, has meant less viable and less biomass of coral polyps and subsequently less exoskeleton secretion.

Two research teams have noted that the numbers of symbiotic dinoflagellates within several coral species in the Australian waters, while not “bleached,” are nevertheless substantially less in numbers per coral cell and less viable within the symbiosomes of the coral cells as opposed those growing in the other geographical regions.(1) Related inquiries in all the study regions indicate that some of the coral tissue that once appeared whitened in some areas are showing at least temporary signs of recovery, despite the fact that seawater temperatures, a known cause of the demise in the first place, remain high (2). Nevertheless, most findings and forecasts from researchers indicate a bleak future for coral reefs based in large part on PAR intensity (3). Ironically, causality-seeking biochemical investigations indicate that when this light intensity is combined with increased water temperatures, the energy from the dinoflagellate dark reactions is greatly lowered and consequently photoinhibition mechanisms are less effective. (4)

Long-term data also supported recently shows that major tropical storms involving torrential and prolonged rains increase coral mortality (5). This coral mortality appears to be exacerbated near the mouths of many river systems (6). One curious investigation showed that some corals that are “bleached” of its symbionts have the host animal tissue still intact, while other whitened corals lack the animal tissue (7). Several researchers unfamiliar with coral reef biota dynamics reported their continued amazement that reefs remain as viable as they are despite the heavy and constant bombardment of wave action, most particularly storm waves (8)

Mystery challenge #1

CAS Bi503 Symbiosis

A suspect has finally been captured in the notorious and dastardly pilferage of the tennis netting at a nearby urban park. The alleged thief was nabbed by a self-styled Holmes whose scholarly side-disciplines included the study of symbiosis.

He claimed that the capture was due to his knowledge of this obscure but growing science field and was based upon three clues:

(1) grass roots of the type found at the park court on the soles of the suspect's shoes which under microscopic analysis showed the clear presence of mycorrhizae;

(2) the seizing of a vast cache of assorted lichens which natural history records from the Boston Athenaeum Library indicate were very abundant in this tennis court area throughout much of the early part of this century; and

(3) a startling ribosomal-RNA sequencing match between primary endosymbiotic bacteria found in aphids scattered about at the court site and with primary endosymbiotic bacteria of the same aphid species found in the suspect's apartment.

Rate this symbiologist-detective. **Elaborate** and **clarify** as to why he is or is not on the right track?!

Vehicles for fostering thinking/learning:

- ✓ Students in instruction roles

Students in an instructor role…

…fosters…

- Internalization of content
- Organization of ideas and thoughts
- Self-reliance
- Collaboration
- Accountability
- Communication

Simple re-useable approach…

- Clear overhead transparency sheet per partner, small group or individual
- Water-based markers

or,

- Large easel sheets with markers
- Criteria-based guiding rubric necessary

Vehicles for fostering thinking/learning:

✓ Explainers

"say, what…?" exercises

Say, what? Explainer #1
CAS Bi117 Global Ecology

Clear in-your-own-words explanations needed…!

Beetles may be the key to understanding what is the actual diversity of life on earth.

Much of biodiversity protection policy can arguably be based upon "just in case" and eco-ignorance reasoning.

The concept of keystone species may be effectively applied to global conservation plans by recognizing "hotspot" (keystone) regions.

The statistics, which generally show a gradient of decreasing species diversity as one moves from tropical regions to the poles, may be illusory.

Available soil moisture may be the single-most important determiner of biodiversity in land areas.

The arrival of angiosperms is one of the great turning points in the history of life on earth.

Beetles may be the key to understanding what is the actual diversity of life on earth.

The estimate of the number of species on earth has increased due in part to the realization that different insects can be found a massive numbers in the middle and upper canopies of trees in rainforest regions for example. In one tree, 163 species of beetle were found and extrapolating this to the numbers of tropical trees (over 50,000), there would be over 8 million beetle species alone. The number of micro-habitats in the canopies is so great that natural selection has favoured the filling of diverse small niches with minimal overlaps.

Much of biodiversity protection policy can arguably be based upon "just in case" and eco-ignorance reasoning.

Somewhat related to the concept of preserving gene banks, the original sets of genes of species in their non-anthropogenic environs, is the view that there may be some economic, medical, or ecological need for certain species. And, "just in case" there is such an eventuality, it would be wise to keep as many species going as possible. Eco-ignorance is another factor, for we have only begun to understand the earth and its processes. Thus, allowing fostering policies that promote species removal may end up removing species that we could later discover were important to food webs, climate change, or other situations.

Say, what? Explainer #2
CAS Bi117 Global Ecology

Hey, what's going on?

1. The Peruvian economy suddenly struggles as fish populations, particularly anchovies, become severely reduced.

2. Major volcanic eruptions in Indonesia appear to counter the well-recorded increase in global warming, despite its releasing significant carbon dioxide!

3. London is at a latitude very similar to Goose Bay, Labrador, around 50-55 degrees north, yet, south central England averages thirty degrees Fahrenheit warmer!

Say, what? Explainer #3
CAS Bi117 Global Ecology

The following situations need some clarification, wouldn't you say…?

1. Agricultural policy in a specific geographical region calls for increased nitrogen fertilizer to enhance the rate of growth and quality. More nitrate is added to the soils. Yet, measurements see no increased uptake of nitrogen from the soils. More nitrate is added, but there is still no increase. Instead, high levels of nitrogen and other nutrients are found in nearby water systems. This must have something to do with the soil…

2. Even in areas where there is no "acidic rain," the soils can be somewhat acidic and in this condition actually enhance ecosystem viability…..

3. Tropical rainforests are extremely productive, with tonnes of diverse and luxuriant biomass per hectare. Yet, analysis of the tropical soil (oxisol) shows it to be relatively nutrient-poor…..

Vehicles for fostering thinking/learning:

✓ Literacy-building…

“so, what’s wrong exercises”

So, what's wrong...? analysis #1

CAS Bi117 Global Ecology

It's a lovely day but with a chill wind and some approaching grey clouds on the horizon. You are meandering about the shore north of Boston, avoiding the glorious tidal suds, glancing admiringly at microbial covered granitic rocks scattered about your path, admiring the masterful patterns left in the wet mud by the retreating water. But, another step brings you to the edge of a mystery, a journey of new understanding -- for before you tapping at your heel in the watery motion is an empty light green wine bottle with something inside.

After filling the bottle with water and shaking it out, a soaked paper emerges in hand. The message in the bottle is remarkable, for it concerns topics near and dear to you -- global ecology. The mystery of its origin has a sad and misguided tinge, as some of what is written is remarkably inaccurate. It may have even been a contribution to the apparent depression suffered by this forever hidden author. With colleague adjacent, you tackle the bottled letter, identifying appropriate falsehoods and correcting it…

Dear Friends,

I write this from my earth enclave 228 km. from the sun…so far, yet everything that surrounds me seems dependent on that massive ball of hydrogen and molten iron. Have you ever stopped to realize the profound importance of a gas such as carbon dioxide? It makes up only 3% of the earth's atmosphere, yet it is needed by every photosynthesizer. These same autotrophs, as well as heterotrophic organisms later respire this carbon dioxide in a process known as respiration. Respiration allows each animal and plant cell to utilize oxygen in order to process carbon-based food. In this process, carbon dioxide is released into the atmosphere. The main problem with global warming today that is getting me so down

is that we are depleting carbon dioxide so fast that these photosynthesizers will not have enough of this gas. Oxygen would then build up and expand the current ozone shield and thus hold in too much heat on the planet. It's scary, especially because outside of the early Cenozoic, there is no evidence of other warmings in the past!

I am also concerned about the planet's kidneys! What I mean are the wetlands areas, which in effect act as a filter in that biome. For

example, wetlands are dominated by anaerobic life in the muds among the plant roots, and the overall rate of decay due to lower oxygen levels is much slower. Thus an overabundance of nutrients such as nitrates or phosphates that enter a wetland will be taken up by plants and bacteria there and held for some time. Drainage of the wetlands, on the other hand, allows oxygen to enter the system and thus all the wetland plants rapidly decay and die out and could then become extinct.

On top of all this, I've been thinking about our depleting resources. We are dependent on all these elements and the compounds and minerals they make up, but we are just throwing them away by removing them from the earth. Once we use up the fuels that came mostly from fossil animals like dinosaurs, the earth can never be enriched with those elements like Carbon again - - unless of course we are bombarded by carbon containing asteroids, which is so preposterous in that such calamities have of course not affected our giant blue and stable home in the past.

It's all rather depressing -- I mean I see signs of disaster everywhere. I look in the oceans and they are gray and filled with smelly polluting algae; I read about eutrophication and know that the pond and lake will die out permanently; I see cities of concrete and realize that nature has been forever removed from our cities. I hope that whomever finds this message has a little different view and will write to me clearly at Five Cummington Street, Boston, room 221.

yours,

Dante

So, what's wrong…? Analysis #2

CAS Bi117 Global Ecology

You have stumbled into a speech on evolution. You are thinking you could really gain something from this, but the talk sounds odd to you at times. Indeed, parts really do need correction. Identify excerpts from the speech below that appear incorrect by circling and then put in the correct words, phrases, sentences nearby.

…Life on the planet really needed several situations to evolve. This includes the position of earth with respect to our star, the sun. A second factor is the breakdown of certain elements in the innermost portions of the planet. This breakdown of calcium and helium emitted so much energy over millions of years, that it caused a build up of hot gases. These gases escaped to the surface and can be seen as hot springs and vents in the world today.

Another influence on life has been the movement of the plates in the earth's crust. The continents are part of these plates and, due to convection currents below, move in various directions over geological time. Thus, one ecosystem can be replaced by another depending upon how far the continent has moved into new climate regions.

Volcanic upheaval also plays a key role in life. Although volcanoes are relatively rare – occurring only in scattered locations and releasing lava very infrequently – they contribute most of the elements that make up the chemical compounds that make up life today, including ourselves.

So, what's wrong? an analysis #3
SED SC511 Science teaching methods

You've checked the mail, and there is a letter from your friend who has decided to share some of what she has learned in her methods class, thinking perhaps that it might help you in yours! But, as you move along, it becomes clear that she's missed the boat here and there! Circle what you think is incorrect or inappropriate and then write a correct statement(s) next to or on the reverse side.

...One of the most exciting concepts was that of inquiry teaching. Inquiry teaching revolves around the teacher functioning as an engaging conversationalist. The instructor listens well as part of the conversation, and poses occasional questions to guide the students. Questions that help the student to focus on a specific answer are divergent questions and these are the centerpiece of inquiry based

discussion learning. Those questions that allow for a more broad response and get students to more fully express what they are thinking and what they believe are called convergent questions. These should be used deftly, for they can easily cause confusion. It can be so easy to have a class go off on tangents and lose focus. The point of a good organized teacher is to get the students to be tuned in to what the teacher is thinking. Teachers must model thinking and behaviour in science for the students.

. . . I have also learned that things like “wait time” are important...that is, when you pose a question to the students, allow

two to three seconds for a response. Don't just start giving the answer. Patience is important. I did witness an excellent discussion in a high school class I observed the other day. The teacher was excellent for he got one student to respond and then he would comment and another student would add to that and she would comment further or reinforce, and this went back and forth for about fifteen minutes. Students were talking and working off of the instructor. This suggests a high level student inquiry....

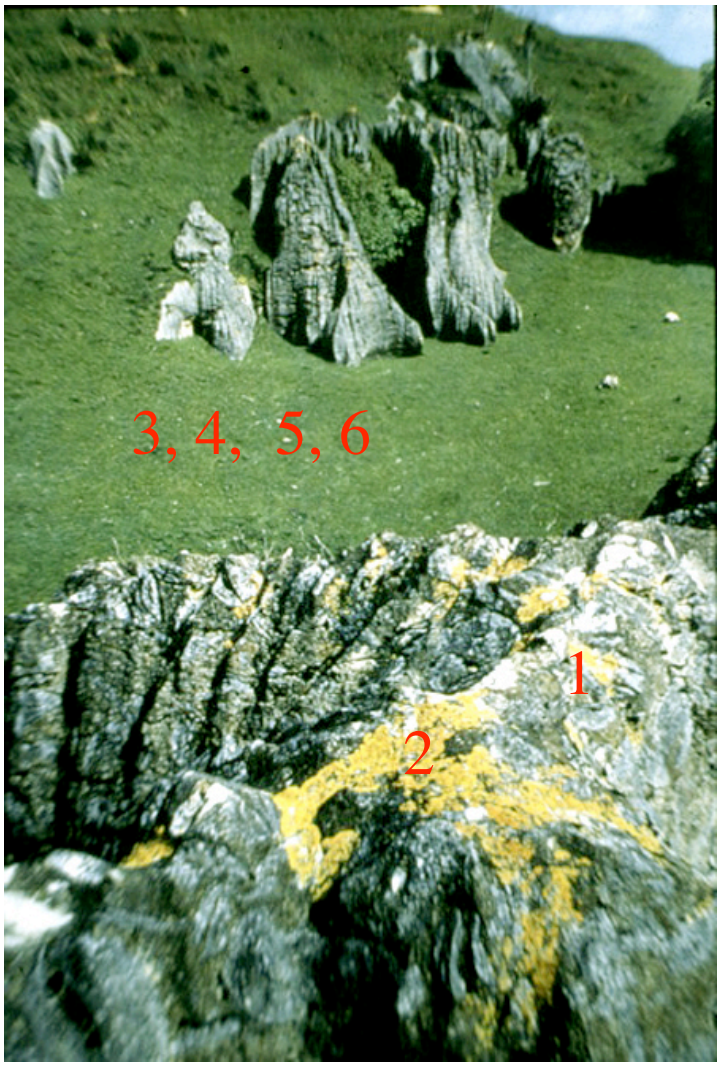
Vehicles that foster thinking/learning…

- ✓ Visual image analysis

Visual image analysis example

Bi503 Symbiosis:

Interpret this image symbiotically…



“5 E’s” in curriculum design that promote thinking/learning

- Engagement
- Exploration
- Explanation
- Elaboration
- Evaluation

Bloom's cognition domains

- Evaluation
- Synthesis
- Analysis
- Application
- Comprehension
- Knowledge

Summary of vehicles to promote thinking/learning

- Refutations
- Case history analysis
- Students in the role of instructors
- Explainers (“say, what?”)
- Literacy-builders (“so, what’s wrong…?”)
- Visual image analysis

Strategies that foster thinking/learning

- Peer-to-peer discussion opportunities,
- Operating from stories, contexts,
- “Physical” interaction (groups, materials, stations),
- Creative, product/outcome-driven,
- Consistent challenges, and
- Avoid telling, emphasize discovery

Thank you!

Feel free to contact me at
dzook@bu.edu