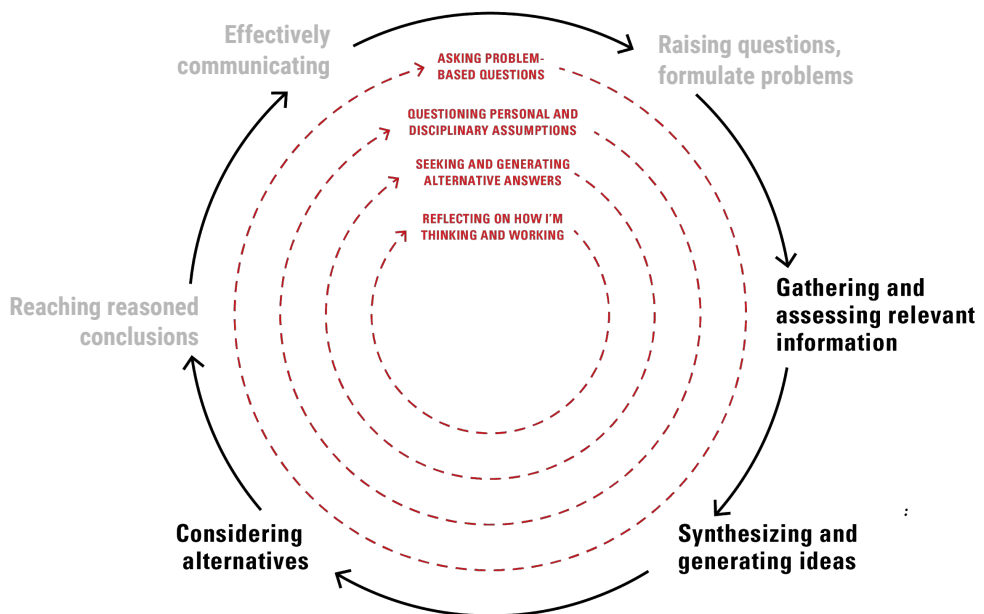


Discipline-specific Critical Thinking Scenarios



Skills Practiced



Sue's Data

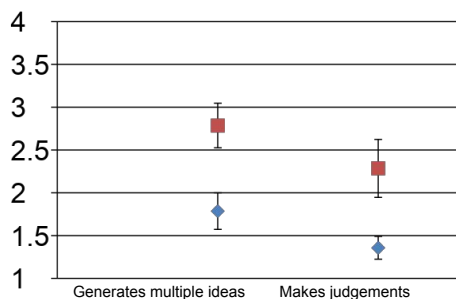
	Skill Assessed by CAT Question	Max points	Pre Mean	Post Mean	Probability of difference ^a	Effect size ^b
Q1	Summarize the pattern of results without making inappropriate inferences.	1	0.71	1.00	*	+ .86
Q6	Provide alternative explanations for spurious associations.	3	1.93	2.36	*	+ .69
	CAT Total Score	39	23.33	26.02	*	+ .67

Transferrable gains measured by CAT

Mean scores on pre-/post- Critical Thinking Assessment test. N=14

a. * $p < .05$ ** $p < .01$ *** $p < .001$ (2-tailed)

b. Mean difference divided by pooled group standard deviation. (0.1 - 0.3 = small effect; 0.3 - 0.5 = moderate effect; >0.5 = large effect)



Discipline-specific gains on research papers

Mean rubric scores with standard error of control group versus test group. N=14 for both groups. $p = 0.0064$ and $p = 0.016$ (2-tailed) for each question respectively.

Blue = control; Red = THINK

Carson, S. 2015. Targeting critical thinking skills in a first-year undergraduate research course. *JMBE*. 16 (2): 148-156.

Specific Skills

- Provide alternative interpretations for information or observations that have several possible interpretations.
- Identify additional information or evidence needed to evaluate the alternative interpretations.

Sample Scenario (exaggerated)

A scientist working in a government agency believes that an ingredient commonly used in bread causes criminal behavior. To support the hypothesis, the scientist notes the following evidence:

- 99% of criminals consumed bread prior to the criminal activity.
- Crimes rates are extremely low in areas where bread is not consumed.

Questions:

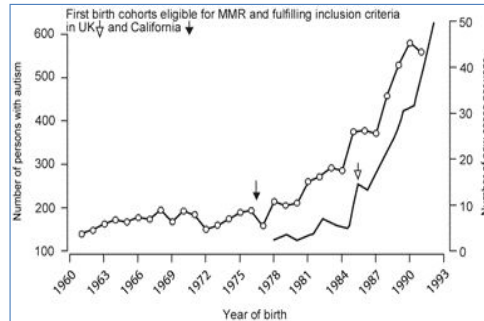
1. Do the data strongly support the hypothesis?
2. Are there other explanations for the data besides the scientist's hypothesis? If so, describe.
3. What kind of additional information or evidence would support or oppose the scientist's hypothesis?

Public Health Scenario 1

“But my Dad had the vaccine and still got the flu.”

1. Does this statement strongly support the idea that flu vaccines are not effective?
2. What are some alternative explanations for Dad getting the flu, besides that flu vaccine is not generally effective?
3. What other information would you need in order to support or oppose the different explanations?

MMR/Autism Scenario



Wakefield AJ. *Lancet* 1999;354:949-50

1. What does the author of the graph want you to infer?
2. Give an alternate explanation for the data shown in the graph.
3. Suggest further data that you could gather to investigate the alternatives above.

Overstated conclusion in Primary Lit.

The 2014 publication by Lu *et al* entitled “Sub-lethal exposure to neonicotinoids impaired honey bees winterization before proceeding to colony collapse disorder” in *Bulletin of Insectology* has received considerable media attention. In the study, the researchers set up an experiment with 18 bee colonies. All 18 colonies are fed a constant supply of either a sucrose or HFCS syrup over a period of 13 weeks from July 2 – Sept 17. In 12 of the colonies, neonicotinoid pesticides were added to the syrup in a sub-lethal dose of 0.74 ng/bee/day.

Bees were permitted over-winter, as normal. The researchers observed no difference in the treated versus non-treated hives during the summer and fall months. However, in April, 6 of the 12 neonic-treated colonies were dead, and 1 out of 6 non-treated colonies were dead.

Furthermore, in the neonic-treated hives that had not successfully overwintered, few dead bees were found in the hive (as occurs in CCD), whereas many dead bees were present in the one control hive that did not successfully overwinter. The authors state that the data strongly support the idea that neonicotinoid poisoning is the primary cause of Colony Collapse Disorder.

- How strongly does the data support the conclusion that neonicotinoid poisoning is the cause of the widespread problem of colony collapse?
- Describe any problems you see with the experimental design or conclusion reached in the paper.
- What further information would you need to assess the veracity of the conclusion (either known information or further experimentation that could be pursued)?

Article review write-up

- What was the overall question/problem addressed by this paper? Define the **scope** of the problem that was explored (**depth, breadth/perspective**)?
- Select one experiment detailed in the results section of the paper (usually each experiment has one or more figures associated with it), and summarize the following:
 - What question was addressed? Was it/why was it **significant** to the study?
 - What was done (broadly, not specific protocol steps)? Were the methods employed **appropriate** to address the problem/question?
 - State the result obtained and its **relevance** to the overall question addressed by the paper.
- Who is the intended audience for this article? Was this article written with **clarity** for the intended audience?
- Did the conclusions follow **logically** from the data? Provide an example.
- Did the authors consider **alternate conclusions** of the data? Provide an example. **Are there any interpretations that you thought about that the author did not consider?**
- Given the findings and approach taken in this work, does it lead you to any questions you would like to address with respect to the *P. larvae* phage we are studying in our research project? **List as many research questions as you can think of. Select one research question and provide a possible methodology to pursue (briefly). Explain why you selected the above research question from among your alternatives.**

Possible Kinds of Topics

Data generated in class:

Students design an experiment but neglect an important control. They must describe all of the possible interpretations of the data and figure out how they should redesign the experiment to rule out some of the possibilities.

Current Headlines:

- Girls Who Play Soccer Have More Success in STEM Fields
- Frequent Reliance on Social Services Yields Shorter Life Span
- Eating Fast Food Leads to Depression

Overstated claims in primary literature (students can read entire paper, or summary of data and conclusions drawn)

Create a Scenario

Set up scenario – headline, figure from a journal article, public misperception of something in your discipline, results of an experiment that is consistent with more than one interpretation, etc.

1. Does the evidence strongly support the conclusion?
2. Are there other possible explanations? If so, describe.
3. What kind of additional information or evidence would support or oppose the original conclusion or any of the alternatives?

Acknowledgements

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