Assessing Critical Thinking by Designing an Experiment to Test a Hypothesis

The project: Each **s**tudent is required to develop an experiment to test a hypothesis. Although such a project is usually evaluated as part of a grade in a capstone course where the instructor is looking at writing skills, information literacy skills, and knowledge in the discipline, it can also be used to evaluate critical thinking. To do this, you could include the following questions as a part of the assignment (most of which you would expect a student to address even if you were not assessing for critical thinking). Here are the questions you might ask:

Questions asked as part of report:

1. Identify all data that will be collected and clearly explain how the data is relevant to the hypothesis.
2. Clearly describe possible outcomes of the experiment and how each outcome will support or refute the hypothesis.
3. What assumptions are you making, based on your knowledge of the discipline, in your experimental design?
4. What are the limitations of your experiment in testing your hypothesis?
5. What follow-up experiments can you suggest to test the hypothesis?

Notice that questions 1-3 generally address the first SUNY critical thinking learning outcome (students will identify, analyze, and evaluate arguments as they occur in their own and others work) and questions 4 and 5 generally address the second learning outcome (students will develop well reasoned arguments).

Scoring is suggested as follows (see rubric for values):

SUNY Learning Outcome 1: sum of scores for questions 1, 2, and 3

8-9 exceeds expectations **4-7 meets expectations** **0-3 does not meet expectations**

SUNY Learning Outcome 2: sum of scores for questions 4 and 5

5-6 exceeds expectations **3-4 meets expectations** **0-2 does not meet expectations**

Rubric to Assess Critical Thinking for Designing an Experiment to Test a Hypothesis

	Does not meet (0)	Approaching (1)	Meets (2)	Exceeds (3)
Experimental Design: The experimental design tests the hypothesis of interest. **CT-1**	• The data to be collected are not relevant to hypothesis.	• Some data to be collected are relevant to hypothesis, and some are not • Additional data needed to thoroughly test hypothesis	• All data to be collected are relevant to the hypothesis • Additional data needed for a thorough investigation of hypothesis	• All data to be collected are relevant to the hypothesis • There is sufficient data for a thorough investigation of the hypothesis
Possible Outcomes: The student can describe the possible outcomes and explain how each supports or refutes hypothesis. **CT-1**	• Student does not know or understand the predicted outcome of the experiment	• Several possible outcomes are identified • some confusion in the explanation for how each supports or refutes the hypothesis.	• Several possible outcomes are identified • adequate explanation for how each supports or refutes the hypothesis	• All possible outcomes are clearly identified • accurate and complete explanation for how each supports or refutes the hypothesis
Assumptions: The student has identified assumptions in the experiment based on his/her knowledge of the discipline **CT-1**	• no assumptions identified • experiment demonstrates little or no understanding of the discipline.	• at least one assumption identified • experiment demonstrates some understanding of the discipline.	• Some assumptions identified • experiment demonstrates good understanding of the discipline.	• Major assumptions clearly identified • experiment demonstrates excellent understanding of the discipline
Limitations: The student can evaluate their proposed experiment in terms of limitations and strengths **CT-2**	• cannot identify limitations of experiment	• identifies some limitations of experiment but not in terms of testing hypothesis • cannot clearly explain reasons for limitations	• identifies limitations of experiment in testing hypothesis • explains reasons for limitations based mostly on logical thought	• accurately identifies limitations of experiment in testing hypothesis • explains reasons for limitations based on logical thought
Follow-up Experiments: The student sees the next logical scientific step after their experiment. **CT-2**	• student does not propose any experiment as a logical follow-up to this one.	• student suggests a follow-up experiment, but it does not really test the hypothesis	• student suggests a reasonable follow-up experiment that will test the hypothesis	• student suggests more than one follow-up experiment • explains the follow-up experiment in detail, • is able to prioritize and indicates the "best" follow-up experiment from a logical perspective.

adapted from: http://www3.wooster.edu/teagle/docs/AndersonReport%20on%20Creativity%20and%20Critical%20Thinking%20Assessment%20Exercise%20-%20Fall%202007.pdf