Learning Critical Thinking Through Astronomy: Scientific Validity

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STUDENT NOTE

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Contents

Questions

When scientists say, "The answer is..." in response to a question, what is this really a shortened way of saying?

Materials Needed

For this activity, you will need the following materials:

- a pencil (do not use ink)
- the ability to read and follow directions

Points To Remember

Unless otherwise explicitly instructed, your responses must not contain personal opinions. All of your responses must be in the form of complete sentences; the fewer sentences the better. Spelling and grammar must be correct. Effective communication is essential for both learning and doing science.

Don't ask instructors for answers to questions posed in activities; you won't get them. You may ask questions regarding the clarity of the instructions or the soundness of your reasoning. If you encounter a word you are not familiar with, don't ask the instructor about it. Look it up first in your glossary and then a dictionary or some other source if necessary. Ensure that all definitions are unanimously agreed upon before proceeding. There are, of course, sound reasons for these policies. See the instructor if you have questions, but do not complain about these policies. They are not negotiable.

1 Criteria For Validity

To be scientifically valid, a claim or argument must be *testable* and *falsifiable*.

1.1 Meaning of Testable

To be *testable* means that there exists some experiment(s) that can be performed or observation(s) that can be made in an attempt to verify the claim or argument. Valid testing has at least two possible outcomes. If an experiment or observation has only one possible outcome, it is not valid. If the claim involves anything supernatural, it is inherently not testable and therefore not scientifically valid.

1.2 Meaning of Falsifiable

To be *falsifiable* means that one possible outcome of an experiment or observation conclusively shows a claim or argument to be not true. A claim that can only be shown to be true is called a *tautology* and is not scientifically valid.

2 Putting It To Use

1. Consider the everyday observation that in the absence of clouds or any other obscuring medium, the daytime sky here on Earth is blue. What causes this? Make a list of **no more than ten** candidate explanations you can think of to explain the daytime sky's perceived color. Don't worry about an explanation being correct or incorrect. You're basically just brainstorming here. Consider **everything** you can think of no matter how far fetched it may sound.

Response

2. For each explanation you came up with in the previous question, rule out **as many as you can**. For each explanation that is ruled out, give the justification for ruling it out. Be as specific as you can and feel free to give **evidence** you may be aware of. You may need to carry out additional simulations and activities to rule out some of your explanations that can't otherwise be ruled out. You may not be able to construct a simulation or activity for some of your explanations. If this is the case, think about what this means.

Response

3. If there are any explanations for which you cannot construct a simulation or activity, list them here.

Response

At this point, you should only have one remaining explanation, and it is most likely the correct one. **The process you have just gone through to get the most probable explanation is called *science*.** Learning to rule out explanations based on evidence is an important part of *critical thinking*, and critical thinking is an important part of science.

4. State the most probable explanation here.

Response

3 Inquiry

When answering the following questions, it is important that you not use examples that have been given in class. The point of this activity is to make up your own. It will not be easy because you probably have never been asked to think about these things before. Testability and falsifiability are the cornerstones of scientific validity and form much of the foundation for critical thinking within science. You must be able to recognize them, or their absence, when confronted with new ideas, claims, and arguments.

5. Give an example of a claim that is both testable and falsifiable, and explain how you would go about testing the claim. It is absolutely essential that when you state each and every possible outcome of that test. If there is only one possible outcome then the test is not a good test even if that one outcome supports the claim. There must be a minimum of two different test outcomes. To be falsifiable, one of the outcomes must be that the claim is not true.

Response

6. Give an example of a claim that is testable but not falsifiable, and explain how you would go about testing the claim. Remember to list each possible outcome of the test if you think there's a test.

Response

7. If possible, give an example of a claim that is not testable but is falsifiable. Again, remember to consider each possible outcomes of any test you think exists.

Response

8. If possible, give an example of a claim that is neither testable nor falsifiable. Again, remember to consider each possible outcomes of any test you think exists.

Response

9. Can a claim be falsifiable and still be true? If so, give an example. Again, remember to consider each possible outcomes of any test you think exists.

Response

10. Can a claim be scientifically valid and still be untrue? If so, give an example. Again, remember to consider each possible outcomes of any test you think exists.

Response

11. Can a claim be scientifically invalid and still be true? If so, give an example.

Response

12. Discuss the extent to which a person's professional or academic credentials play a role in scientific validity. Can credentials be abused?

Response

13. Based on everything you have learned thus far, determine whether or not each of the following academic disciplines can be considered science. Defend your decisions with good arguments.

- sociology
- entomology
- economics
- law
- accounting
- history
- Christian science
- mathematics
- finance
- etymology
- psychology
- theology
- astrology

Response

14. Was there one particular explanation that you *wanted* to be the most likely explanation? State which one and why you *wanted* it to be the most likely explanation.

Response

15. Consider this claim: Your instructor has an invisible pet dragon living in his garage. Establish whether or not this is a scientifically valid claim and, if so, describe in detail the tests you would carry out.

Response

16. Consider astrology. Can it be tested? Does it make falsifiable predictions? Is astrology science? Can you think of anything else like this?

Response

17. Are definitions subject to testing and falsifiability?

Response

18. Can an extremely complicated test, one that may take many thousands of years to carry out, be handed down from one generation to the next? Must a test be confined to one human generation's duration?

Response

19. When scientists say, "The answer is. . . " in response to a question, what is this really a shortened way of saying?

Response

20. Does either the testability or falsifiability of a scientific claim depends on the era in which one lives? Are these limited by one's current technology?

Response

21. Is it appropriate to say that without being falsifiable, a claim is also not testable?

Response

|——— CHECKPOINT ———|

22. Map this activity into as many of the elements of thought as you can.

Response

23. Every activity will have at least one standard associated with it.

STANDARD

I can assess whether or not an explanation is testable and falsifiable.

4 Feedback

What could be done to make this activity more interesting? Please be honest.

Response