

Where Do We Stand? Activities to Assess Our Own Views of the Nature of Science

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What is the nature of science?

- *Definition:* the epistemology of science, science as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge.
- In other words, everything but the content.
- Science through the lens of philosophers, historians, sociologists, and (some) scientists.

Why teach the nature of science?

- NOS has been defined as a critical component of scientific literacy (NSTA, AAAS, NRC)
- National Science Education Standards:
 - The Scientific Worldview
 - Scientific Inquiry
 - The Scientific Enterprise
- And... context, context, context!

Assessing our views of the nature of science

How do you view science?

Nature of Science Card Exchange

1. You need a set of 6 randomly drawn cards.
2. Evaluate your cards according to what you can most and least confirm.
3. Examine each other's statements and make trades. The goal is to improve one's hand by trading cards one for one. There is no discarding.
4. Again, wander around looking at other player's cards with the goal of finding someone to pair with. Each pair must hold eight cards with which they have relative agreement. The pair's remaining four cards are discarded.
5. Next, pairs match up to form foursomes. Each foursome should hold eight cards. Once your foursome is established, rank your cards. You may discard the two bottom-ranked cards if you wish.
6. Based on the final set of cards, cooperate to write a statement on the nature of science.

How do you view science?

Based on the cards you kept, do you fall into any of these categories?

Theoretical Emphasis

Science is primarily a rationalistic, theory-driven endeavor. Observations and investigations are directed by theory. Theories are the main goal of science.

Theoretical Emphasis

- Science is open-ended, but scientists operate with expectations based on the predictions of theory.
- A theory is what scientists strive for: a large body of continually refined observations, inferences, and testable hypotheses.
- Theories help scientists interpret their observations: facts do not speak for themselves.
- In general, scientists plan investigations by working along the lines suggested by theories, which in turn are based on previous knowledge. Theories serve to give direction to observations, i.e., they tell one where to look.
- A theory is a logical construct of facts and hypotheses that attempts to explain a range of natural phenomena and that can be tested in the natural world.
- Good science cannot be done without good theories.

Empirical Emphasis

Science is primarily a data gathering, experimental endeavor in pursuit of physical evidence. Objective observations and experimentation are at the heart of science.

Empirical Emphasis

- Observation is central to all of science, i.e., seeing is believing.
- A scientist should not allow preconceived theoretical ideas to influence observation and experimentation.
- Unless an idea is testable, it is of little or no use; thus, scientists attempt to convert possible explanations into testable predictions.
- Careful, repeatable observation and experiment give the facts about the world around us.
- Good science always begins with observations.
- Science is never dogmatic; it is pragmatic-always subject to adjustment in the light of solid, new observations.
- A phrase such as “Many scientists believe..” misrepresents scientific inquiry because scientists deal in evidence.

Anti-Science View

Science is overrated. One should not give much credence to the aims, methods or results of science. Scientists are not objective; money and prestige drive science.

Anti-Science View

- Science is always changing and therefore is not very reliable.
- Scientists should be held responsible for harm their discoveries have caused, e.g., pollution, nuclear weapons.
- Earning recognition from other scientists is really the main motivation of more scientists.
- Most of what scientists do will never be of much practical value.
- Money spent on projects such as NASA space flights would be better spent on healthcare for the needy.
- Science destroys values and morality by disparaging the unique nature of men and women.
- Science and religion are fundamentally at odds.

Scientism

Science is the way of knowing; it is the perfect discipline. Other disciplines should utilize the methods of science. Because of their way of looking at problems, scientists are in a unique position to make decisions about many non-scientific issues.

Scientism

- The scientific method should be followed in all fields of study.
- Scientists and engineers should make the decisions about things like type of energy to use because they know the facts best.
- Science is the most important way of gaining knowledge open to humanity.
- Science knowledge is of much greater value than any other type of knowledge.
- Only science can tell us what is really true about the world.
- Science knowledge is always objective and self-correcting.
- Credit for our advanced way of life must go to science and scientific progress.

Cultural View

Science is embedded in a social, historical, and psychological context which affects all that goes on in science. It is not shielded from its culture, making objectivity impossible.

Cultural View

- Funding influences the direction of science by virtue of the decisions that are made on which research to support.
- The scientific enterprise is situated in specific historical, political, cultural, and social settings; thus, scientific questions, methods, and results vary according to time, place, and purpose.
- The predominance of men in the sciences has led to bias in the choice and definition of the problems scientists have addressed. This male bias is also one factor in the under-representation of women in science.
- Scientific facts are manufactured through social negotiations. Nature has nothing to say on its own behalf.
- Scientists in one research group tend to see things alike, so even groups of scientists may have trouble being entirely objective.
- The Early Egyptians, Greeks, Chinese, Hindu and Arabic cultures are responsible for many scientific and mathematical ideas and technological inventions.
- Until recently, some racial minorities, because of restrictions on their education and employment opportunities, were essentially left out of the formal work of the science establishment. The remarkable few who overcame these obstacles were even then likely to have their work disregarded by the science establishment because of their race.

Are there merits to all of these views?

- Theoretical emphasis?
- Empirical emphasis?
- Anti-science view?
- Scientism?
- Cultural view?

Changes in our view of science...

Philosophy



History



Sociology

Empirical

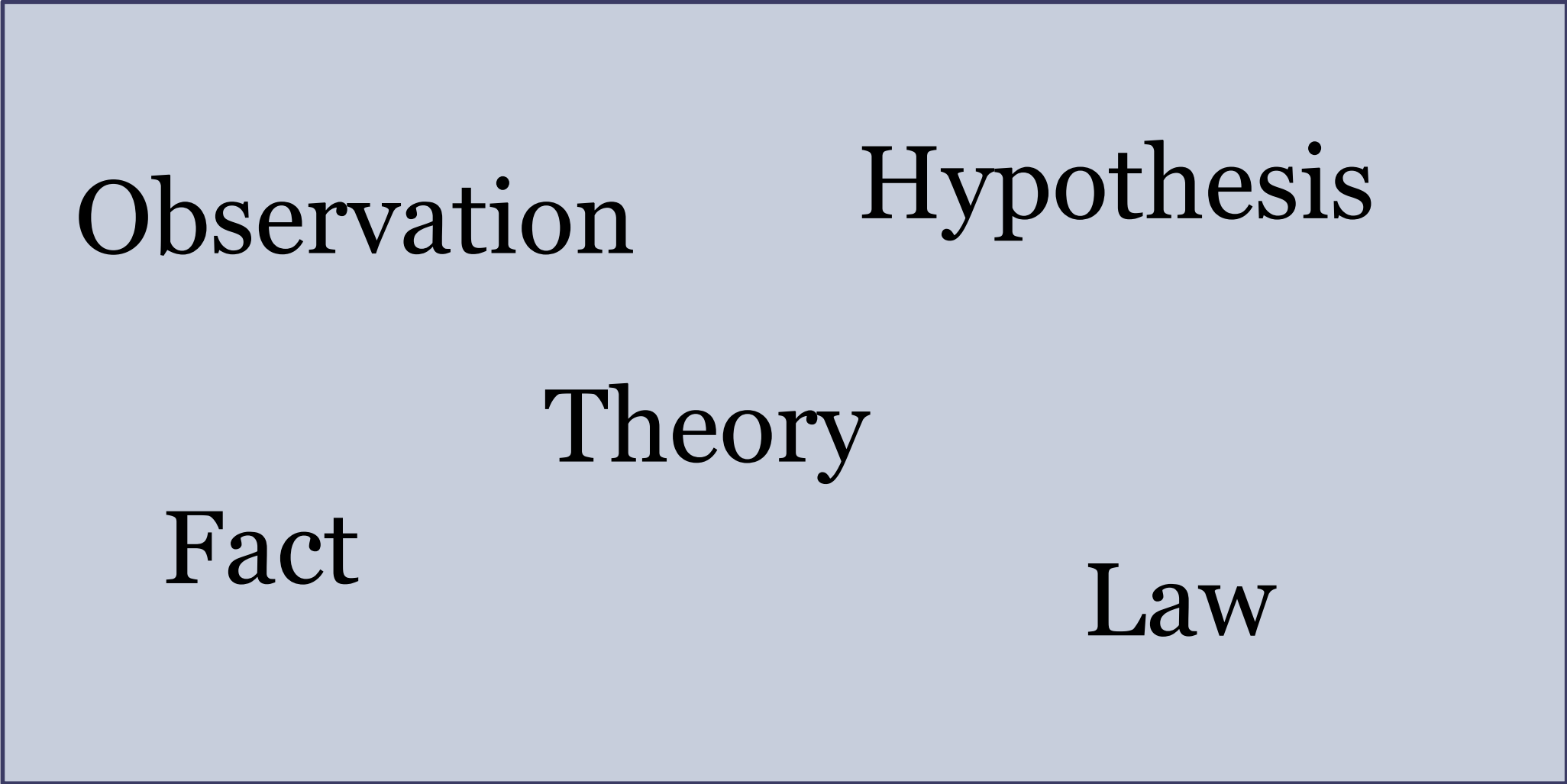


Theoretical



Model-based

The terminology of science



Observation Hypothesis

 Theory

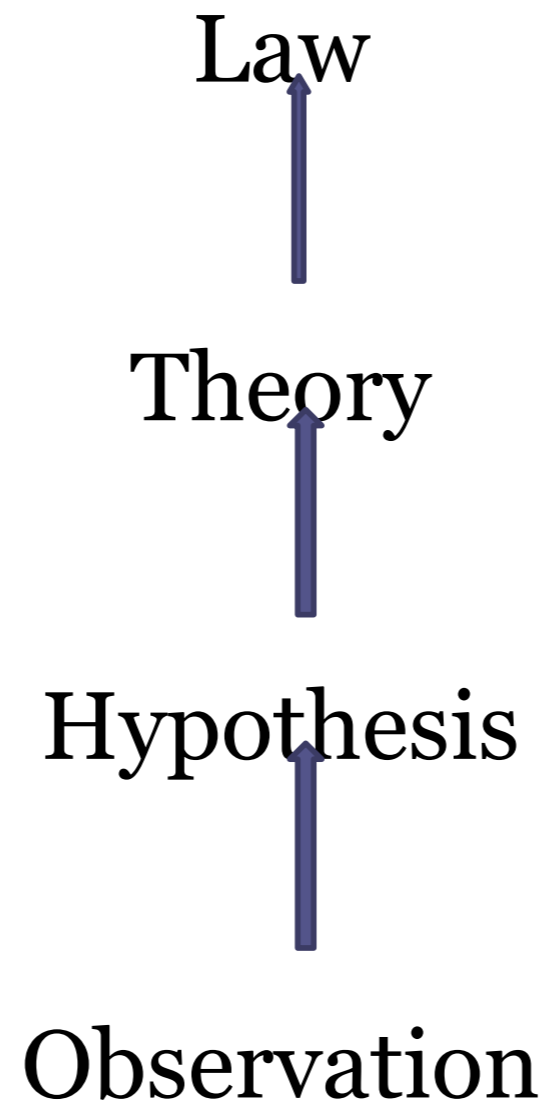
Fact Law

Which is more certain?

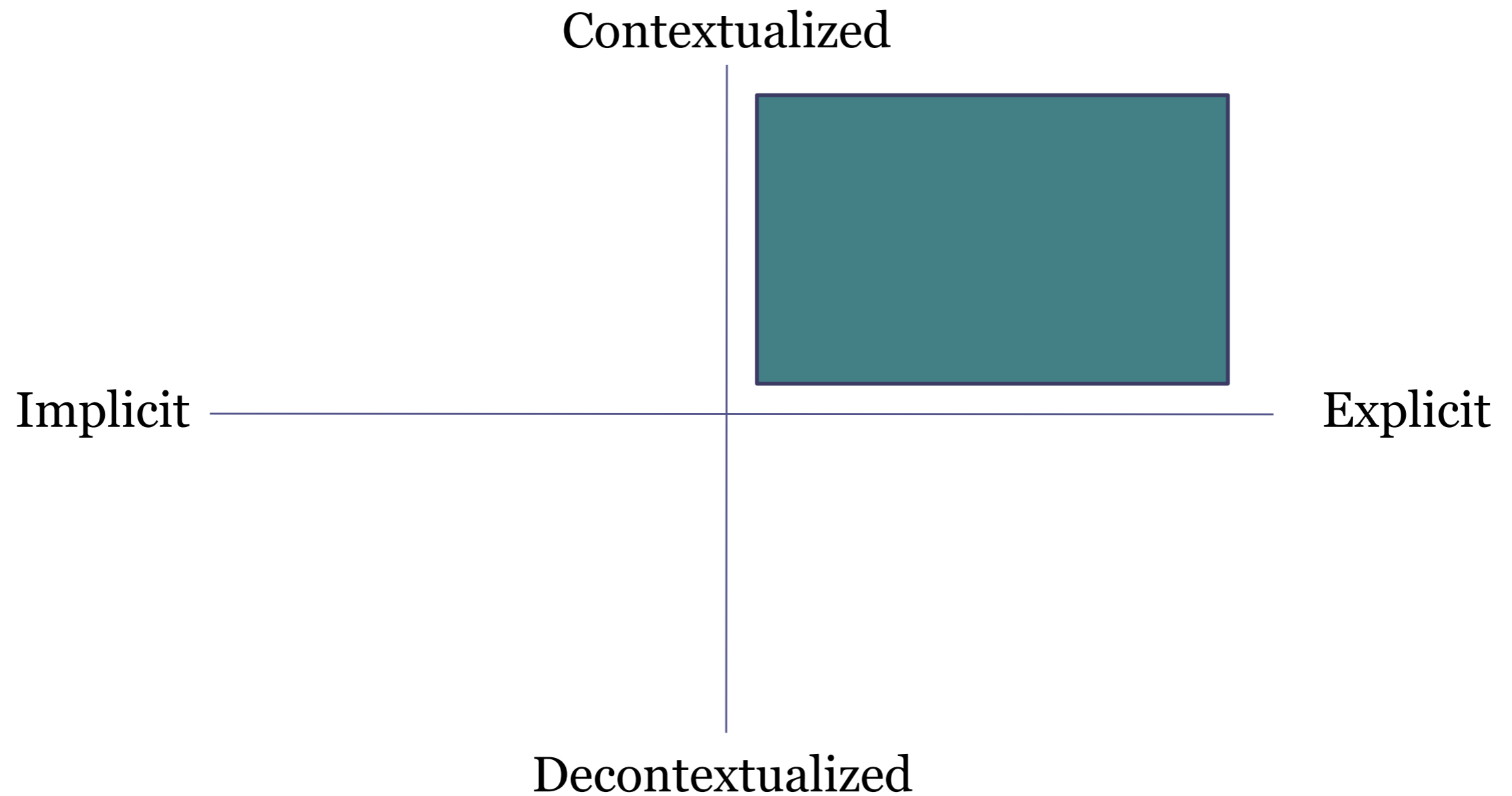
Definitions...

- Fact – An observation that has been repeatedly confirmed. (Preponderance of evidence)
- Observation – A description of the natural world.
- Law – A concise description of a regularity, usually obtained by generalizing from a set of observations.
- Hypothesis – A testable statement about the natural world that can be used to build more complex inferences and explanations.
- Theory – A well-substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences, and tested hypotheses. (Explains and predicts)

Misconception?



Teaching the nature of science



The end...

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