

Dr. Williams' website

- <http://facstaff/kwillia4/Ecol&Evol/ecol&evol.htm>

Scientific reasoning (hypothetico - deductive model)

Step 1: Observation

Step 2: Develop a tentative explanation (theory) about how the universe works. (note this explanation may be based on observation, logic, common sense or the creativity of the scientist)

Scientific reasoning (hypothetico - deductive reasoning)

Step 3: Use deductive logic to create a hypothesis based on the tentative explanation. (The hypothesis is a statement that must be true if the explanation is correct)

Step 4: Collect data to test the hypothesis.

Scientific reasoning (hypothetico - deductive reasoning)

Step 5: Reject or accept hypothesis

Step 6: re-evaluate explanation and other explanations

Step 7: Communicate your results

Theories and Hypotheses & Hypthetico-Deductive Reasoning

1. Theories are explanatory – theories are tentative efforts to explain why a phenomena occurs.
2. Hypotheses are derived from the consequences of the theory, and predict what will happen in a specific circumstance.

Contrast with “common” definition of theory and hypothesis.

“Hypothesis is an educated guess”

“Theory is a well supported hypothesis”

Some Important Characteristics Of The Hypthetico-deductive Reasoning

Where do theories come from?

The imagination of people

What makes a good theory?

1. Does not contradict what is already known.
2. Makes predictions that can be tested.

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Advantages of the hypothetico-deductive reasoning.

1. Does not require that everyone agree on broad premises to begin with.
2. Allows new theories to be developed when new information becomes available.
3. Allows old theories to be discarded when observation contradict the predictions of the theory.
4. Relies on observations that anyone can make to judge the validity of a theory.

Disadvantages of the hypothetico-deductive reasoning.

1. Because it uses deductive logic to create the hypotheses logical errors can lead to erroneous conclusions.
2. Because it relies on inductive logic to make generalization about specific observations it can not “prove” anything to be true.
3. It is only applicable to phenomena that can be observed, measured and quantified.
(It can not, for instance, be used to gain knowledge about love, morality, or omnipotent beings)

Hypothetico-deductive reasoning is not the only form of reasoning used by scientist.

Scientist use all forms of reasoning and argument.

When little is known about a subject theories may be developed based entirely on inductive reasoning.

When little data is available deductive logic may be used exclusively.

But the hypothetico-deductive reasoning is the “preferred” method.

Quick summary

- Knowledge can created by reasoning.
- **Deductive logic** accepts broad generalities as true and makes inferences about specific cases.
- **Inductive logic** observes specific incidents and makes inferences about broad generalities
- **Hypothetic deductive reasoning**
 - Preferred method for science
 - Use both inductive and deductive logic
 - Has strengths and weaknesses.

Game plan

- Discuss selected characteristics of science
- Discuss why students struggle with science.
- Discuss ethics and science

Selected Characteristics of Science

1. Based on observation.
2. Self-correcting.
3. Relies on sharing ideas and information.
4. Fosters creativity and competition.
5. Creates new knowledge by developing better and better explanations of how the world works.

Why Student's Struggle with Science

1. Accumulated knowledge

Hundreds of thousands of theories have been developed, millions of observations have been made.

To keep from wasting time it is necessary to know about many of these.

Why Student's Struggle with Science

2. Details matter

The difference between the predictions made by two theories may rest on very small detailed differences.

3. Facts, theories and reasoning must all be understood.

Why Student's Struggle with Science

5. Some explanations and theories are based on **mathematics or probability theory**.

6. Science demands creativity.

7. Science requires that you challenge rather than accept.

Science and Ethics

Because morality and ethics can not be objectively observed and measured science can not be used to make inferences about what is right and wrong.

Science can educate us about the consequences of our actions and that may lead to changes in what is considered ethical.

Science and Ethics

There are ethical standards in science.

1. Be Objective (minimize bias).
2. Judge the data and the logic not the person.
3. Honesty is required in reporting observations.
4. Don't waste time and money.
5. Credit the work of your colleagues.

Quick Summary

- Students struggle with Science because ..
 - Accumulated knowledge
 - Details
 - Math
 - Demands Creativity
 - Requires questioning rather than acceptance
- Science can not be used to make inferences about what is moral or ethical correct.
- There are Ethical standards in science