Scientific Reasoning

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Scientific reasoning is the foundation supporting the entire structure of logic underpinning scientific research.

It is impossible to explore the entire process, in any detail, because the exact nature varies between the various scientific disciplines.

Despite these differences, there are four basic foundations that underlie the idea, pulling together the cycle of scientific reasoning.

Observation

Most research has real world observation as its initial foundation. Looking at natural phenomena is what leads a researcher to question what is going on, and begin to formulate scientific questions [1] and hypotheses [2].

Any theory, and prediction, will need to be tested against observable data.

Theories and Hypotheses

This is where the scientist proposes the possible reasons behind the phenomenon, the laws of nature governing the behavior.

Scientific research uses various scientific reasoning processes to arrive at a viable research problem [1] and hypothesis. A theory is generally broken down into individual hypotheses, or problems, and tested gradually.

Predictions

A good researcher has to predict the results of their research, stating their idea about the outcome of the experiment, often in the form of an alternative hypothesis [2].

Scientists usually test the predictions of a theory or hypothesis, rather than the theory itself. If the predictions are found to be incorrect, then the theory is incorrect, or in need of refinement.

Data

Data is the applied part of science, and the results [3] of real world observations are tested against the predictions.

If the observations match the predictions, the theory is strengthened. If not, the theory needs to be changed. A range of statistical tests is used to test predictions, although many observation based scientific disciplines cannot use statistics [4].

The Virtuous Cycle

This process is cyclical: as experimental results accept or refute hypotheses, these are applied to the real world observations, and future scientists can build upon these observations to generate further theories.

Differences

Whilst the scientific reasoning process [5] is a solid foundation to the scientific method [6], there are variations between various disciplines.

For example, social science, with its reliance on case studies [7], tends to emphasis the observation phase, using this to define research problems [1] and questions.

Physical sciences, on the other hand, tend to start at the theory stage, building on previous studies, and observation is probably the least important stage of the cycle.

Many theoretical physicists spend their entire career building theories, without leaving their office. Observation is, however, always used as the final proof.

Links
[1] https://explorable.com/defining-a-research-problem

[2] https://explorable.com/research-hypothesis
[3] https://explorable.com/statistically-significant-results
[4] https://explorable.com/statistics-tutorial
[5] http://philosophy.hku.hk/think/sci/hd.php
[6] https://explorable.com/what-is-the-scientific-method
[7] https://explorable.com/case-study-research-design