Processess involved in scientific research process

Science

PROCESSESS INVOLVED IN SCIENTIFIC RESEARCH PROCESS 1. General Question The starting point of most new research is to formulate a general question about an area of research and begin the process of defining it. This initial question can be very broad, as the later research, observation and narrowing down will hone it into a hypothesis. For example, a broad question might ask 'whether fish stocks in the North Atlantic are declining or not', based upon general observations about smaller yields of fish across the whole area. Reviewing previous research will allow a general overview and will help to establish a more specialized area. Unless you have an unlimited budget and huge teams of scientists, it is impossible to research such a general field and it needs to be pared down. This is the method of trying to sample one small piece of the whole picture and gradually contribute to the wider question. 2. Formulate a question: The question can refer to the explanation of a specific observation, as in " Why is the sky blue?", but can also be open-ended, as in " Does sound travel faster in air than in water?" or " How can I design a drug to cure this particular disease?" This stage also involves looking up and evaluating previous evidence from other scientists, as well as considering one's own experience. If the answer is already known, a different question that builds on the previous evidence can be posed. When applying the scientific method to scientific research, determining a good question can be very difficult and affects the final outcome of the investigation. 3. Hypothesis: An hypothesis is a conjecture, based on the knowledge obtained while formulating the question, that may explain the observed behavior of a part of our universe. The hypothesis might be very specific, e. g., Einstein's equivalence principle or Francis Crick's " DNA makes RNA makes protein",[12] or it might be broad, e. g., unknown species of life dwell in the unexplored depths of the oceans. A statistical hypothesis is a conjecture about some population. For example, the population might be people with a particular disease. The conjecture might be that a new drug will cure the disease in some of those people. Terms commonly associated with statistical hypotheses are null hypothesis and alternative hypothesis. A null hypothesis is the conjecture that the statistical hypothesis is false, e. g., that the new drug does nothing and that any cures are due to chance effects. Researchers normally want to show that the null hypothesis is false. The alternative hypothesis is the desired outcome, e. g., that the drug does better than chance. A final point: a scientific hypothesis must be falsifiable, meaning that one can identify a possible outcome of an experiment that conflicts with predictions deduced from the hypothesis; otherwise, it cannot be meaningfully tested. 4. Prediction: This step involves determining the logical consequences of the hypothesis. One or more predictions are then selected for further testing. The less likely that the prediction would be correct simply by coincidence, the stronger evidence it would be if the prediction were fulfilled; evidence is also stronger if the answer to the prediction is not already known, due to the effects of hindsight bias (see also postdiction). Ideally, the prediction must also distinguish the hypothesis from likely alternatives; if two hypotheses make the same prediction, observing the prediction to be correct is not evidence for either one over the other. (These statements about the relative strength of evidence can be mathematically derived using Bayes' Theorem.) 5. Test: This is an investigation of whether the real world behaves as predicted by the hypothesis. Scientists (and other people) test hypotheses by conducting experiments. The purpose of an experiment is to determine whether observations of the real world agree with or conflict with the predictions derived from an hypothesis. If they agree, confidence in the hypothesis increases; otherwise, it decreases. Agreement does not assure that the hypothesis is true; future experiments may reveal problems. Karl Popper advised scientists to try to falsify hypotheses, i. e., to search for and test those experiments that seem most doubtful. Large numbers of successful confirmations are not convincing if they arise from experiments that avoid risk.[13] Experiments should be designed to minimize possible errors, especially through the use of appropriate scientific controls. For example, tests of medical treatments are commonly run as double-blind tests. Test personnel, who might unwittingly reveal to test subjects which samples are the desired test drugs and which are placebos, are kept ignorant of which are which. Such hints can bias the responses of the test subjects. Failure of an experiment does not necessarily mean the hypothesis is false. Experiments always depend on several hypotheses, e. g., that the test equipment is working properly, and a failure may be a failure of one of the auxiliary hypotheses. (See the Duhem-Quine thesis.) Experiments can be conducted in a college lab, on a kitchen table, at CERN's Large Hadron Collider, at the bottom of an ocean, on Mars (using one of the working rovers), and so on. Astronomers do experiments, searching for planets around distant stars. Finally, most individual experiments address highly specific topics for reasons of practicality. As a result, evidence about broader topics is usually accumulated gradually. 6. Analysis: This involves determining what the results of the experiment show and deciding on the next actions to take. The predictions of the hypothesis are compared to those of the null hypothesis, to determine which is better able to explain the data. In cases where an experiment is repeated many times, a statistical analysis such as a chi-squared test may be required. If the evidence has falsified the hypothesis, a new hypothesis is required; if the experiment supports the hypothesis but the evidence is not strong enough for high confidence, other predictions from the hypothesis must be tested. Once a hypothesis is strongly supported by evidence, a new question can be asked to provide further insight on the same topic. Evidence from other scientists and one's own experience can be incorporated at any stage in the process. Many iterations may be required to gather sufficient evidence to answer a question with confidence, or to build up many answers to highly specific questions in order to answer a single broader question. References ï‚· Brody, Thomas A. (1993), The Philosophy Behind Physics, Springer Verlag, ISBN 0-387-55914-0. (Luis De La PeÃ±a and Peter E. Hodgson, eds.) ï‚· Bruno, Leonard C. (1989), The Landmarks of Science, ISBN 0-8160-2137-6 ï‚· Bynum, W. F.; Porter, Roy (2005), Oxford Dictionary of Scientific Quotations, Oxford, ISBN 0-19-858409-1. ï‚· di Francia, G. Toraldo (1981), The Investigation of the Physical World, Cambridge University Press, ISBN 0-521-29925-X. ï‚· Einstein, Albert; Infeld, Leopold (1938), The Evolution of Physics: from early concepts to relativity and quanta, New York: Simon and Schuster, ISBN 0-671-20156-5