

What is Science?

In my PhD program, I was trained to be a researcher. I have conducted research and published research. I have taught research. I have supervised research done by doctoral students. I have evaluated research as a consulting editor for a number of professional journals. In short, I know something about a scientific approach to doing research. Perhaps not everyone qualified to speak to this topic would agree with what follows but it is, in my opinion, a valid description based on my experience. I think I can, at the very least, posit an informed opinion.

Science should not be confused with technology. Technology is very often derived from scientific findings but may be the product of trial and error by artisans who haven't a clue about any underlying scientifically established principles. An iPod is not science. A prosthetic device is not science. An antibiotic drug is not science. A space shuttle is not science. All of these may be artifacts or byproducts of science but in the final analysis they are simply technology because science isn't a thing or a product it is an investigatory process.

First and foremost science is a process employing systematic methods. Initially, science is a process for establishing relatively objective and observable facts about some aspect of experience that is subject to direct or indirect observation and measurement. Once a sufficient body of related facts are established a scientific theory or theories are proposed to account for those facts. In other words, an explanation or explanations are proposed that the proposers think best account for the related facts. Science is not, for example, chemistry. Chemistry is one area (or discipline), among many others, of investigation that is characterized by a widely agreed upon set of facts, integrated by an explanatory theory and focused upon validating that theory and expanding its scope through scientific investigation. Essentially, the same statement applies to all areas or disciplines that employ the scientific process.

A scientific theory is not "just a theory" in the sense of "one guess is as good as another" or merely speculation. A scientific theory must offer a reasonable accounting for the related facts it is intended to explain. A theory can be called into question by significant facts coming to light that it cannot explain. In such a case, the theory must be reformulated to explain the new facts or it must be rejected and a new theory sought that can explain all the established facts. It is not the case that a theory that appears to account for the established facts is correct. To be a scientific theory it must be a plausible explanation that is capable of yielding testable hypotheses.

The scientific process depends upon an evolving body of systematic methods used to test hypothesis or predictions derived from theory. When those hypotheses or predictions are validated by well designed and carefully conducted research using scientific methods, the findings add support to the theory from which the hypotheses tested were derived. If they are not validated by the research then they call into question the theory. Replication is the repeated testing of a particular hypothesis by independent researchers. Replications that

confirm the initial results add further support for the theory and confidence in its validity. When a large number of hypotheses have been tested and replicated, a theory becomes established as the preferred explanation for a particular class of phenomena. Theories must be revised or replaced when facts inexplicable by the theory arise or tests of critical hypothesis derived from the theory fail.

Scientific theories are always considered to be merely approximations or models of reality, not descriptions of reality. Thus, a theory is never true in any absolute sense. It is only a tentatively held approximation that is often useful in practical ways. When scientists come to believe that a theory is true and rationalize away contradictory facts or experimental results that fail to support the theory, it is no longer a scientific theory but scientific dogma. It has morphed into *scientism* and its advocates are no longer scientists in the proper meaning of the term.

A scientist is someone who adheres to the scientific process and is committed to the tentative nature of scientifically validated facts and the theories explaining them. Scientific methods and theories evolve within a paradigm (see *A Brief Comment on Paradigms* on the "Opinion" page at <http://www.davidcenter.com>), which is a set of guiding assumptions about the nature of phenomena and how we can understand them. Failure of theories can but seldom do call into questions the underlying paradigm in which they evolve.

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