Journal of Theoretics

Guest Commentary

Volume 5-5, Oct-Nov 2003

Science Defined

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Science: *A many branched discipline that exclusively practices the objective asking, answering, and recording of verifiable questions about nature; it uses experiment, observation, modeling, laws, theories, hypotheses, and open criticism (validation or invalidation) to accomplish this goal. It explicitly does not rely on any super natural forces to explain all natural phenomena.*

It is very important to understand that within the discipline of science there are no absolute truths, and as such scientific knowledge is open to the sharpest criticism from anyone that can present different or new answers based on repeatable observations and experimentation. This creates a constant state of flux in any area of particular study until enough evidence is gathered that experts in the particular field formulate one or more theories, something that often happens very slowly. Often times the conflicts between alternate theories are resolved with further experimentation and observations, which results in the emergence of a dominant theory. Such a theory must have the ability to explain the given phenomena and have the ability to make predictions of further experiments and observations. If a dominant theory does this over a long enough period of time it approaches the category of established fact; an example would be the theory of evolution. The overall results from such methodical processes are truly wondrous because they very clearly and most adequately provide explanations for many of the phenomena of nature from the origin of the universe itself to the formation of life and its subsequent evolution into its incredible diversity.

The fact that science truly answers some of the most intriguing questions that we may ask is reason enough to want to learn it. It is equally important to understand that it can't answer any question that is not verifiable. For example, if I were to ask at what temperature in degrees centigrade does ethanol boil at sea level; it wouldn't be too hard to set up an experiment to obtain the correct temperature. On the other hand, if I asked the question, why is stealing evil, it would be unanswerable because it lies outside the arena of science; there simply is no way to set up an experiment or take any measurements to provide an answer. This is an ethical question that can only be answered by philosophers or spiritualists.

A great deal of science (especially physics, chemistry, and biology) requires following the scientific method, which is a process that follows steps. First, a question is asked; second, several possible answers are considered; third, the most likely answer is formulated into a hypothesis; fourth, controlled experimentation is carried out; fifth, the data from the experiment is analyzed to see if it supports the hypothesis. If it supports the hypothesis then the entire process is carefully written following traditional and rigid guidelines, whereupon it is submitted to a scientific journal for publication. After it is published and criticized by experts in the field, it too is added to the body of scientific knowledge as support for a theory or perhaps ultimately a law. If the experiment does not support the hypothesis then other hypotheses need to be formulated and tested by experimentation.

Considering the definition of science as a discipline, it should be noted that a person can add to the body of scientific knowledge without carrying out formal experiments, and thus also be practicing science. To give an example, suppose a collector finds what is thought to be a yet to be described species of butterfly, and takes field notes, pictures, and collects male and female specimens; next the collector searches the body of taxonomic knowledge and compares the data from the new specimens to closely related previously described species to determine if, indeed, it a new species. The collector then writes a complete description of it and submits it to a science journal, such as the one published by the American Lepidopterists Society. At this time other butterfly experts are able to read about it and criticize it. If it stands this scrutiny then it is formally added to the ever-expanding body of scientific knowledge. Another example of practicing science without formal experimentation would be in astronomy where observation alone is paramount. Think about the impact that Edwin Hubble had on mankind in 1924, when he determined through pains taking observations with a new large telescope, the existence of Cepheid variable stars in M31. At that moment (although it had to be properly recorded, published, and confirmed) it was apparent that galaxies were composed not of just gas, but rather, countless stars. The universe became much, much bigger, and we were no longer alone in a single cluster of stars. That was, indeed, a giant leap forward for mankind's scientific knowledge.

It’s very important to realize that by just gathering data, like making a collection or making careful observations of nature and not doing anything with the gathered data does not constitute practicing science. In the two examples above, the butterfly collector and the astronomer took their data (along with an ample dose of experience and intuition) and carefully analyzed it by comparing their findings with closely related published scientific knowledge (much of which would already be in their heads). When they decided that they had new discoveries they wrote a scientific paper describing them and submitted these papers for publication. After the discoveries were published, they had done science.

Lastly, if you are studying science by reading a book or any other medium like TV or the internet , don’t be misled into thinking you are doing science. You may be able to say you are doing biology or geology and be very correct, yet you are only studying science, not doing science.

Glossary of terms used in the context of science:

1. **scientific method**: The formal procedure of asking and answering a verifiable question about nature that follows these steps: observation > question > hypothesis > experiment > answer > publication.

2. **observation**: A recorded experience of one or more of the five senses of a scientist working on an experiment or project.

3. **objective**: Impartial observation or analysis of data by a scientist.

4. **hypothesis**: The best guess of a scientist in answering a verifiable question prior to experimental evidence bearing an answer.

5. **theory**: An explanation of a natural phenomena that has been tested by repeatable observation and experiment. It cannot be proven, only supported or disproved by further experimentation or observations.

6. **law**: A concise factual statement that explains an action or actions of nature.

7. **mode**l: A simplified, and often mathematical, scaled down representation of a particular system, situation, or process.

Other online definitions of science and terminology:

http://www.journaloftheoretics.com/Editorials/Vol-1/e1-3.htm

http://www.csicop.org/youngskeptics/education/resources/sciencedef.html

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