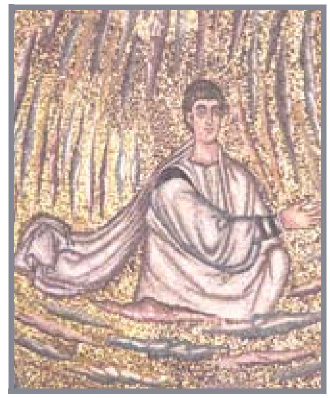
Science

In spite of our utter reliance on it, few people today actually know what science is. This confusion is often exploited by those attempting to bend us to their own agendas.

an essay by Alan Yoder



The term *science* is used to mean many things today. Its supporters and detractors both use it to mean things that it is not. The unfortunate lay person is left to wonder what the real story is, with no real guide for determining who is talking rot and who is not. I'll try to help sort this out a bit here.

The most divisive thing about science is that it is somehow identified with pure materialism, which seems to pit it against all the great religious traditions. I will explain why this is a fallacy and a misconception about a simple but profound process. I'll also explain the difference between facts, theories and natural laws.

I've lumped the problems and misunderstandings just mentioned into something that I call "the modern confusion." I don't mean anything special by that; it's just a handle for a grab bag of related issues.

The scientific method

You've no doubt heard about the *scientific method*, possibly preached in reverent tones in grade school. The thing is, a fifth grader does not yet have the mental equipment to appreciate the profound insight embodied in the scientific method, and so does not absorb it. Subsequent curricula somehow fail to reinforce the lesson, and so we are left with generations of people who literally cannot tell you the difference between a theory and a fact.

The scientific process or method is roughly this:

(1) Develop a *hypothesis* about how something works, or alternatively just get curious about it.

(2) Make some observations about events related to the hypothesis or question, perhaps with help from equipment.

(3) Develop a *theory* about what caused the events that is able to make predictions about other similar events.

(4) Attempt to verify the theory's predictions against subsequent events.

(5) Refine or reject the theory based on its partial success or failure.

(6) Make sure that others are independently able to reproduce your results. This establishes your theory as believable.

A very simple example of this is the following exercise. Suppose you want to figure out what a cross wind will do to the path of a falling drop of water. What happens may go something like this:

(1) You're curious about the effect of a wind on falling drops of water, so you decide to perform an experiment.

(2) First, get a faucet dripping. Make a mark where the drops are falling. Next, repeat the process with a fan blowing at low speed and mark where the drops fall. Double the fan speed and make another mark. Double the speed again and mark again.

(3) From your observations, it appears that wind deflects the drops in a super-linear way, meaning that a wind that is twice as strong moves the drop more than twice as much. You develop an equation that describes this. Your *theory* is that this

equation matches perceived reality and can be used to predict it.

(4) Double the fan speed yet again and make another measurement.

(5) If your equation nailed it, you have a strong case for your theory. Otherwise, you need to repeat the process, and work on your equation some more, or quit and have a martini (my cookbook has a recipe for this if you need one).

(6) Final success of your theory lies in the hands of your scientific peers, who will experimentally verify your results. That is to say, they will reproduce your experiment and test your equation against measurements that they've taken themselves, and validate or invalidate it. Annoyingly, it only takes one good counter demonstration—in which your equation didn't work— to shoot down your theory. The counter demonstration must also be repeatable by others of course.

Repeatability of results is the cornerstone of the scientific method.

Theories and facts

In the above example, your working theory is that wind deflects falling drops of water in such and such a way that is predicted by an equation you've developed or adapted. Over time, as the reliability of your equation becomes established, it may come to be accepted as a *fact*. This is incorrect, and is part of the modern confusion. The correct way of referring to it is to call it a *natural law*, as Newton's Laws of Motion or the elements of thermodynamics are called. It is never correct to call a natural law a fact (even though trained physicists do it all the time).

- *Facts* are things we observe.
- *Laws* are ways of characterizing and predicting the things we observe.
- *Theories* are statements of belief that one or more proposed laws are indeed true and applicable to a given set of facts.

As theories are statements of belief, they are subject to change in both substance and degree. The willingness to reexamine accepted theory and change it to accommodate new observations is a key part of what makes one a scientist. Darwin's theory, for example, has been under constant and serious scrutiny for over a century by the very people who accept it as largely on target.

Note that the pecking at Darwin's theory done by its religiously motivated detractors does not count as serious scrutiny. More on this later, as it is some of the most visible evidence of the modern confusion.

Science and mathematics

The study of mathematics is far older than the scientific method. In mathematics (and logic itself) one starts with a foundation of a few *axioms* or *definitions*. These are simple statements that everyone can agree upon. The uncomfortable thing about mathematics and logic is that there is no known way of constructing a mathematical or logical system starting from zip. So the usefulness of your system tends to come down to the validity of your assumptions—the axioms.

For example, modern set theory, which can be used as the foundation for most of modern mathematics, has about ten axioms, which vary slightly depending on whose sauce you like on your ice cream. Modern probability theory has only three [1]:

(1) The probability of an event A is greater than or equal to zero

(2) The probability of an event which is certain to happen is one

(3) If the events A and B are mutually exclusive, then the probability of both of them happening is the sum of the probabilities of each of them happening

From these three axioms—which one has to admit look pretty uncontroversial—all of modern statistical mathematics can be derived.

The process of derivation in mathematics is called *proof*. Probably most of you have had to do proofs in school. You start with some things that were defined or assumed (your axioms), some other things that have been proven to be true based on them (proven *theorems*), and prove new theorems to be true or false based on all of that.

The terms *theorem* and *theory* look related, and that's on purpose. Theorems and theories have the similarity that they represent working attempts to describe the world. But theorems describe a hypothetical world of mathematics in which things *can* be proven or disproven. Theories describe the observed universe, *and can never be called true*. This is because, as noted before, they are beliefs. Furthermore, all it takes is one event that doesn't fit a theory to blow it away, and we don't know what will happen in the future. The theory that the sun will rise tomorrow, for instance, is a very good solid theory with a long history of reliability. There are many facts in its support—a sunrise every day throughout recorded history. But some day, in a few billion years, according to other theories, the sun will go supernova, and consume the inner planets in so doing. No more sunrise and the theory is dead. No more facts either, unless we've moved off planet by then, as there will be no one to observe them. But I digress.

Assumptions

An aside. Above, I mentioned proofs. Proofs are necessary for building mathematics, and mathematics is the preferred way of describing phenomena in science, especially physics. It pays to remember that in all logical and mathematical reasoning, there is the implicit and often unstated rule that what you are proving to be true is only as true as what you started with.

Improper assumptions make many stupidities and outright fraud possible. If you allow an assumption that a number is the same as itself plus one, for instance, it's very easy to "prove" that a dollar is the same as a million bucks. Similarly, many math "paradoxes" are based on an incorrect and hidden assumption that a number can be divided by zero. And almost all magic tricks are based on manipulation of our assumptions about what is going on—a black hat that is black inside is empty, etc.

Assumptions are vital to every conversation, yet are frequently neglected. Many arguments about conflicting conclusions revolved around the reasoning that developed them, when the real conflicts are actually in the assumptions lying behind the reasoning. Resolution of conflicting assumptions is a key part of conflict resolution in many settings

Science and religion

Back to our theme of science and what it is and isn't. There is a common and unfortunate misperception today that science and religion cannot coexist. This seems to be mostly founded on the incorrect assumption that science is based on the doctrine of materialism. Materialism holds that *everything that exists* is material, and that therefore no spiritual world exists.

As you can see, Materialism states an hypothesis which can be neither proven nor disproven by scientific means. Humans have had trouble proving that there is a spiritual world that does have an effect on phenomena that we can measure, so that is something slightly in Materialism's favor. But if there is a spiritual world that doesn't have an effect on phenomena that we can measure, science has nothing to say on the matter. And if there is no such world on the other hand, same deal. So Materialism is simply an unproven hypothesis. The only thing scientific about it is that it fits the definition of hypothesis.

Further proof that there is lots of room for religion in a scientific world is as follows. In the mid 20th century a mathematician named Kurt Gödel devised and proved a theorem, popularized by Douglas Hofstadter in his book *Gödel, Escher, Bach*, which shows that all formal systems are "incomplete." In other words, in every formal system there will be both truths and untruths that cannot be represented, because the very act of representing the ones that are known causes new consequent truths and untruths to now be representable.

Hard science (the kind we usually mean when we say "science") mostly uses mathematics to characterize the world. Gödel's theorem says that this characterization can never be complete, because mathematics is a formal system. This seems to leave room for religion, even without counting all the things that hard science doesn't even pretend to address. Things that happen to us that are not events, such as emotions, dreams, insights and inspiration don't fit the definition of facts that can be observed and measured (though some aspects of them can be). They are the realm of poetry, music and religion. And while science may eventually have some things to say about them, it seems to follow from this one pesky theorem that there will forever be elements of our existence that science *cannot* address.

In my experience, when someone with scholarly or scientific training links science with materialism, they usually have an agenda.

Intelligent Design

The "debate" over Darwinism and Intelligent Design is an outstanding example of agenda-driven discussion of scientific matters. Foes of Darwinism have scriptural reasons for disliking the theory, and wish to propose alternative theories.

There is nothing scientifically wrong with competing theories. The interesting thing is the way in which the anti-Darwin movement has gone about achieving their goals. Their strategy involves, when possible, the correct use of terms to leverage the public's already poor understanding of them.

> *What is the difference between unethical and ethical advertising? Unethical advertising uses falsehoods to deceive the public; ethical advertising uses truth to deceive the public.*
>
> -- Vilhjalmur Stefansson

Building on the definitions given by science itself, the religious right has used Stefansson's principle in declaring that Darwin's theory "is not a proven fact." An understanding of what facts, laws and theories are enables one to answer this easily and correctly. Imagine the conversation between Intelligent Design Advocate Ida and Sane Adult Man Sam,

Ida: "Darwin's theory isn't a proven fact"

Sam: "Of course it isn't. It's a theory!"

Bada bing. Theories are beliefs, not facts.

Further obfuscation and misuse of terms entered the picture with the "theory" of Intelligent Design. It states that the universe is too extravagantly marvelous and well-designed to have originated by accident. This is somewhat like saying that your grandparents had too wonderful of a marriage for their meeting in an elevator in Paris, while each was on vacation, to have been an accident. Yet whether or not Divine action was involved, neither statement has made a prediction that can be experimentally verified, so science is not involved.

There is no "debate" about Intelligent Design because there's nothing for a real scientist to talk about. Intelligent Design is an hypothesis, not a theory. It makes no predictions that can be experimentally verified. This being a fundamental requirement of scientific theories, there's no theory and therefore nothing to debate. Furthermore, Intelligent Design violates the Lesser Anthropic principle. But I digress again.

Intelligent Design's status as an hypothesis, in fact, makes it the dual of Materialism. Both make statements that can neither be proven nor disproven, nor tested in any way. As such, neither is worthy of scientific scrutiny or regard, and I advise thinking persons to avoid them both.

References

[1] Papoulis, *Probability, Random Variables and Stochastic Processes.* McGraw-Hill, 1991.