The myth of absolute truth

Jack K. Horner and Peter Rubba

A recent survey of students taking science at a midwestern American high school disclosed that 30 percent believed that scientific research reveals incontrovertible, necessary, absolute truth. [1] This was so despite the fact that since the late 1950s science curricula have stressed both structure and process, and despite the fact that during this time inquiry has been consistently advocated as the most appropriate mode of instruction.

The emphasis on inquiry has not been for the purpose of making researchers of students, but rather to acquaint students with the fundamental characteristics of science to help them secure a sound foundation for applying scientific knowledge to problems encountered in schooling and in life. [2]

Admittedly, there has been disagreement about what the "fundamental characteristics of science" are. These depend upon how we define the nature of scientific inquiry. Still, it is generally agreed that an adequate treatment of the nature of science ought to dispel the grosser misconceptions of science—including the one we call the "myth of absolute truth."

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Surely, the understanding that scientific knowledge is conditional, never "proven" in an absolute and final sense, is fundamental to being able to use science.

The reasons for a belief in scientifically discovered absolute truth are complex and varied [3]; but two of the more obvious sources are those textbook expositions and teacher behaviors that are at odds with the nature of the scientific process.

Joseph Schwab [4] has described two classes of science textbook language. One pictures science as consisting of unalterable, fixed truths; this he calls the "rhetoric of conclusion." The other, the "narrative of enquiry," offers a fair treatment of the incomplete, tentative, and dynamic nature of science.

For the most part, new curricula and recent revisions of conventional science materials use the "narrative of enquiry," but by no means exclusively. As an illustration, consider the following examples from contemporary science texts—examples which are ambiguous, at the least, about the conditional nature of scientific knowledge:

Unlike civil or moral laws which require and restrict, natural laws tell us what does *occur in nature.* [5]

. . . the great foundations of physics are well laid . . . these remain unchanged . . . [6]

Only if there is a test can the scientist be certain his hypothesis is correct. [7]

The validity of a scientific conclusion is always limited by the method of observation instrumentation and, to a certain extent, by the person who made it. [8]

When a scientist knows what occurs, he is ready to move on to the more stimulating task of determining why the phenomena occur. [9]

The inclusion of investigative laboratory exercises in contemporary science materials and the need for science teachers to mediate class discussion so that it is in accord with the nature of science have created problems teachers may not be prepared to handle. Studies by Carey and Stauss [10], and Rubba [11], for example, suggest that many science teachers do not understand the nature of science well enough to teach it as conditional inquiry. Schmidt found, in fact, that some secondary science teachers' understanding in this area is no better than that of their students. [12]

These results are hardly surprising, for the philosophical nature of science is seldom considered in either preservice teacher programs, or inservice teacher activities. Serious problems, however, can be created by promulgation of the "absolute truth myth." It is worth our while, therefore, to discuss just why scientific knowledge cannot be absolute.

The logic of science

One of the most fruitful ways to characterize scientific knowledge is to say that it consists exclusively of explanations and predictions, all of which can be cast in the form of arguments. For example, we might encounter something like the following:

(D) (1) All material bodies at rest remain that way unless acted on by a force whose vector sum with all other forces on the body is nonzero.

(2) The vector sum of forces acting on this automobile is zero.

(3) Therefore, this automobile will remain at rest.

This is an example of what is often called the *deductive-nomological* (nomos = "law") form of explanation (or *D*). The premises of such an explanation are statements, at least one of which is a scientific law or hypothesis, and one of which (the conclusion, *D*3) describes an event to be explained or predicted. In de-

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ductive explanations the conclusion ($D3$) follows as a logical consequence from the premises, $D1$-$D2$—that is, if the premises are true, the conclusion must always be true.

Deductive explanations are said to be "nonampliative" in the sense that the conclusion "adds nothing" to the premises. In D, for example, we already know (given $D1$-$D2$) that any automobile satisfying these premises will not move; $D3$ tells us nothing new about the behavior of automobiles. Thus, scientific knowledge *cannot* be extended by explanations or predictions like D.

How, then, can science acquire new knowledge? The answer, obviously, is that not all scientific explanations are deductive. Scientists also use *inductive* arguments *(I)*, which *are* ampliative. To illustrate, suppose a scientist of rather limited experience argued as follows:

(I) (1) A black cat was observed yesterday. (True)

(2) A black cat was observed last week. (True)

(3) All the cats I have observed have been black. (True)

(4) Therefore, all cats are black. (True or False?)

Though argument I is ampliative, that is, its conclusion "says more" than the premises, there is something extremely suspicious about it; namely, the conclusion is not a logical consequence of the premises. In fact, we know from our own experience that the conclusion is false, even though I (1–3) may be true. It becomes clear, therefore, that inductive arguments *need not* have conclusions which are known to be certain, even if the premises are known to be true.

We would hope that not many scientists reason as poorly as the one in example I. Just to test our conviction, however, let's look more closely at how a scientist actually "shows" or "proves" scientific laws and hypotheses.

Suppose a scientist wants to show that the distance traveled in time t by all freely falling bodies in Earth's gravitational field is given by $s = -gt^2/2$, where s is the distance traveled in time t, and g is the acceleration due to Earth's gravitational field. He drops several objects (say 0_1, 0_2, 0_3), the magnitude of whose retardation due to air resistance is small compared to the magnitude of the acceleration attained from gravitational forces, and then records the following "observations":

(N) (1) 0_1's fall is described by $s = -gt^2/2$. (True)

(2) 0_2's fall is described by $s = -gt^2/2$. (True)

(3) 0_3's fall is described by $s = -gt^2/2$. (True)

(4) Therefore, the free fall of all material bodies near the surface of the Earth is given by $s = -gt^2/2$. (True or False?)

But something is wrong here—argument N has exactly the same form as the "black cat" example *(I)* above. It is an *inductive* argument. That is to say, the conclusion *(N4)* does not follow as a logical consequence from the premises. Hence it may be that every object observed in human history has a free fall given by $s = -gt^2/2$, but still be the case that the scientific law "The free fall of all material objects in Earth's gravitational field is given by $s = -gt^2/2$" is false.

And worse, N and I are not isolated examples of the way scientists reason; in fact, they are paradigms of the way *every* scientific hypothesis or law is confirmed. The arguments scientists use to extend their knowledge of the world are inductive. Thus, no matter what experiences the human race may have, there is no guarantee that any scientific law is absolutely, certainly true.

This is not to say that because all scientific laws are not certain, any claim about the nature of our world is just as respectable as any other. A given scientific hypothesis may be *relatively* more or less well *confirmed* than another depending on an elaborate array of factors, such as: how many times a hypothesis has been tested, how well it fits the set of theories accepted at a given time, and how many different phenomena it explains. The examples above, nevertheless, do show that *relative confirmation is the most one can hope to attain in science.*

In 1969, the Educational Policies Commission of the National Education Association recommended an awareness of the uncertainty of human knowledge as one of seven characteristics of the scientific spirit and of rational thought which should permeate the educative process. [13] If we expect our citizens to function successfully in a society in which people are called upon to make judgments rooted in science, then the myth of absolute truth must be dispelled, along with all other doctrines of the perfectibility of human knowledge.

Science instruction can dispel the myth, but only if teachers represent science as a dynamic process, and scientific knowledge as the highly confirmed yet conditional product of that process. As James Rutherford has noted, before this can occur:

. . . science teachers must come to understand just how inquiry is in fact conducted in the sciences. Until science teachers have acquired a rather thorough grounding in the history and philosophy of the sciences they teach, this kind of understanding will elude them, in which event not much progress toward the teaching of science as inquiry can be expected. [14]

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For further reading

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