Letters

Scientific Terminology Revisited

Dear Editor:

In a Letter to the Editor published in the Nov./Dec. 1998 issue of *The American Biology Teacher,*[1] Ralph Lewis states that, "One large activity of science is clarifying the meaning(s) of terms." He further states that many scientists, "Having learned the importance of . . . clear meaning(s) of terms in . . . (their) . . . early training as scientist(s), . . . are . . . (now) . . . much disturbed by scientists misusing the terms 'theory' and 'fact'." . . . and by the ". . . public('s) misuse of . . . (the term) . . . theory to mean a hunch or guess (which he contends) prolongs ignorance." However, do scientists/science educators really develop clear meanings of terms like "fact," "theory" and "law" "in their early training," or ever, for that matter? In fact, are there clear, concise and universally accepted meanings of these basic scientific terms as Lewis suggests? It is our contention that clear, concise, universally accepted definitions of such basic scientific terms as "hypothesis," "theory" and "law" do not exist and any attempt to dogmatically proclaim that they do simply further muddies already murky waters.

In an article published in the *Journal of College Science Teaching,* Michael Donovan provides us with evidence to support our contention that there are no universally accepted definitions of the terms "fact," "theory" and "law" that are transmitted to students in their early training as scientists. In a ". . . small, nonrandom, unsystematic sample of 17 (introductory college) textbooks" he studied, Donovan found that:

a. none of the biology texts, ". . . discuss or define law. . .";
b. only one of the three textbooks in geology mentions "law" and this text defines laws as theories that "grow up" by additional testing and validation;
c. one of two chemistry texts distinguishes a theory as a ". . . model that scientifically explains the behavior of nature. . . A natural law does not explain behavior, but simply states a measurable relationship at different experimental conditions." (Donovan further notes that, in this text, "Under law it says, 'see scientific law.' But there is no entry for scientific law.";
d. the large majority of the texts he examined assert that an hypothesis develops directly into a theory by surviving numerous experimental tests.

Fascinated by these two related discussions, we expanded the investigation to include an additional admittedly ". . . small, nonrandom, unsystematic" study of the ways that experienced scientists/science educators, present and past, use the terms "hypothesis," "theory" and "law." What we found was that the diversity in definitions used by scientists/science educators closely parallels the ways these terms are used in college introductory science textbooks. Most working scientists/science educators we polled were generally agreed that an hypothesis is a tentative explanation for observed phenomena that can be objectively tested. However there was far less agreement as to definitions of "theory" and "law." Many of the scientists/science educators polled expressed the belief that a theory is an hypothesis supported by a preponderance of experimental evidence and that a

[1]Lewis, R. (1998). More on theory/fact/evolution debate. *The American Biology Teacher, 60*(9), 649.

law is a broad and unifying theory which has yielded valid predictions of unvarying uniformity (definitions that Donovan refers to as the "... theories-grow-up-to-be laws notion"). Other scientists/science educators expressed the idea that a law and a theory are different concepts—a law states measurable relationships between observed phenomena under different conditions (a "descriptive" concept) while a theory explains why observed phenomena occur (a "mechanistic" concept).

Perhaps, most telling is the way the terms "hypothesis," "theory" and "law" are used in some of the classic readings often assigned in introductory science courses and used, in part, to teach novice scientists/science educators the terminology of science. Most of the authors of these readings made no attempts to define terminology, preferring to define terms "by use." In the process, however, they very often used the terms "hypothesis" and "theory" interchangeably. So, for example, Charles Darwin, even in his earliest discussions, described his tentative explanation of natural selection as the driving force behind evolutionary changes as a "... *theory* by which to work," and his idea that "gemmules" were responsible for heredity as the "Provisional *Theory* of Pangenesis." In the same way, Paul de Kruif, in his classic book, *Microbe Hunters*, repeatedly referred to the hypotheses advanced by Pasteur, Koch, Metchnikoff, et al. as "theories."

Should scientists/science educators use clear, precise, and universally accepted scientific terminology when communicating with their colleagues? Of course they should! Should scientists/science educators impart clear, precise, and universally agreed to definitions of scientific terms when communicating with their students and with the public at large? Of course! However, the reality of the situation is that such clear, precise, and universally agreed to definitions do not actually exist. Perhaps it is with acceptance of this reality that we should begin any dialogue on scientific terminology.

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