PHILOSOPHY OF SCIENCE AND PHYSIOLOGY EDUCATION

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Since the mid-1960s, philosophy of science [particularly that derived from Kuhn’s work (The Structure of Scientific Revolutions, Chicago: University of Chicago Press, 1962)] has become an informal part of the education of scientists worldwide, including physiologists. However, recent postmodernist developments have enraged a number of scientists, who would like to sever any ties with philosophy of science. The author contends that the perceived conflict is due mainly to a misunderstanding of the implications of constructivist assertions and partially to flawed reasoning in a few constructivist approaches. There is no fundamental conflict that would justify the elimination of philosophy of science from science education.


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Thomas Kuhn’s The Structure of Scientific Revolutions (17) has had an enormous influence not only on philosophers of science but on scientists as well, including physiologists. Since the mid-1960s, “paradigms” and “revolutions” have become part of the vocabulary of scientists all over the world. In the biological sciences, many of us think of the theory of evolution by natural selection as a scientific paradigm that replaced a previous paradigm in which evolution resulted from the inheritance of acquired traits. Similarly, many regulatory physiologists think of physiological research before the development of the concept of homeostasis as preparadigmatic science, and whether many of us like it or not, developments in molecular biology have caused a revolution in physiological thought.

Students entering the world of science have been exposed to terms such as paradigms and revolutions either in formal courses or through interactions with their mentors. As a consequence, at least some basic elements of what is called “postmodernist” philosophy of science have become part of science education. Some authors have proposed that postmodernist thought should explicitly guide educational practices in general (23, 24, 27, 29), but this essay will be limited to the informal migration of postmodernist philosophy into the education of young scientists.

To the extent that scientists have informally adopted Kuhn’s (17) ideas for over 30 years, it seems reasonable to assume that postmodernist philosophy of science has a legitimate place in science education. However, as postmodernism has expanded into several forms of “constructivism,” scientists have started to question the need for (or even the acceptability of) philosophy of science in science education. In essence, the complaint is that postmodernist philosophy of science incorrectly asserts that science is neither true nor objective and is no more valid than alternative mythic systems (11, 16, 28). It is clearly time to ask whether scientists are narrow-minded or constructivists are delusional, or both, or maybe neither. I believe that, to a great extent, the conflict is due to a simple misunderstanding of the opinions espoused by the two groups.

POSTMODERNISM AND SCIENCE

The label postmodernism is usually used to describe a wide variety of systems of thought developed in
philosophy and the social sciences during the second half of the 20th century. In English-speaking countries, the beginning of postmodernism is often associated with Kuhn's (17) work. The common element in postmodernist thought is a critical attitude toward received knowledge, a salutary skepticism about the cognitive power of science. This contrasts with a "modern" (positivist) view of science.

As reflected in Auguste Comte's positivist philosophy (5), a long-lasting optimism about the power of science emerged in the mid-19th century. In the first half of the 20th century, logical empiricism brought the positivist ideal to its highest level of sophistication (1). Leaving aside subtleties, the positivist viewpoint is reflected in "our continuing and communal belief that there is one truth 'out there' which can be known, understood, and controlled by anyone who is rational and competent" (13). In other words, a modern or positivist conception of science, which seems to be shared by most contemporary scientists, involves the belief in a real world that exists independently of science, that has structural and functional properties of its own, and that can be objectively known and understood by scientists. According to this viewpoint, today's knowledge may be limited and flawed, but continuing research will eventually provide humankind with the unquestionable truth about the world.

Kuhn introduced a new way of thinking about science by claiming that current scientific knowledge is part of a transitory paradigm that, by necessity, must eventually be discarded for scientific progress to take place (17). In contrast to the positivist belief in cumulative knowledge perfected by successive improvements in experimental methods, Kuhn proposed that progress is a discontinuous process that involves many arbitrary decisions along the way. For example, the transition from Lamarckism to Darwinism was not the result of a gradual improvement in evolutionary research but the result of a revolutionary change from one paradigm to another. Furthermore, even when two theories are not incompatible, their integration into a single system (by reducing the more complex one to the simpler one) may not be feasible. For example, both Mendelian and molecular genetics are part of current biological knowledge, but the former cannot be fully reduced to the latter (14).

Why was Kuhn's postmodernism widely accepted by scientists? It cannot be denied that Kuhn questioned the scientist's conception of science as a cumulative process leading to absolute truths. However, his ideas were not quite revolutionary. Scientists were well aware that in their profession there is a constant swing between adherence to rules of proper scientific conduct (i.e., methodologies, theories, hypotheses, etc.) and the rejection of these same rules to adopt new ideas. The dialectical nature of scientific knowledge was no novelty. Scientists were willing to accept the transitory nature of "normal science" as long as they did not have to give up their faith in an independent empirical world, which they would eventually apprehend through improved paradigms. Kuhn was glad to oblige: although reluctant, he retained the epistemological perspective that beyond sensory experience and scientific paradigms lies an empirical world that can be effectively known (17). More recently, scientists have had no difficulty accepting criticisms of their ability to be purely objective in the pursuit of knowledge. Scientists themselves have pointed out that politics, attitudinal biases, and even trickery are involved in the conduct of science (10, 19, 22, 26). They reason that human flaws are only obstacles to be overcome in the path to the objective knowledge of the world.

POSTMODERNISM AGAINST SCIENCE

The branch of postmodernism that has infuriated scientists is that called constructivism. Constructivism questions not only the notion of continuity in the history of science but also the notion of progress. What many current philosophers, historians, and sociologists argue is that, inasmuch as science is a form of human activity, scientific knowledge is molded by the cultural forces that affect every form of human activity. Consequently, every scientific truth is relative to the prevailing cultural forces, and we cannot possibly reach (or even believe in) an ultimate reality. The label constructivism derives from the belief that scientific truths are made up ("constructed") by cultural forces rather than discovered by objective research. According to this viewpoint, there is no absolute scientific knowledge. All scientific truths are relative to the cultural context in which they develop.

Naturally, the relativity of knowledge is nothing new. Edmund Husserl's (15) impetus to develop phenomeno-
enology in the early 1900s was his concern about how to attain absolute truths despite the relativity of knowledge emphasized by the social sciences. But Husserl, like many other philosophers before him, was fighting against relativity: his goal was to find a rigorous process of inquiry that would allow humanity to attain absolute truths. Such is not the case now. Michel Foucault (7) argues that the language of science is part of the language of a culture and, therefore, it establishes beforehand what can and cannot be discovered by scientific research. David Bloor (3) claims that pieces of scientific knowledge are nothing more than symbols standing for social struggles among scientists. Helen Longino (20) stresses that the logical and cognitive structures of scientific inquiry cannot even develop without a dynamic interaction between scientific practice and social values. To give a more specific example in the biological sciences, Ruth Bleier (2) claims that “the distinctions of human temperaments and personality into feminine and masculine have always been creations, and in our patriarchal cultures are a part of the ideology that attempts to make what are in fact social and political distinctions appear to be natural and biological” (2).

In this context, it is understandable that a bench chemist would be indignant and would reply that “fundamental scientific numbers are objective realities, not social constructs” (16). Indeed, he is right that the velocity of light is 299,792,458 meters per second, and “[n]o sane person would contend otherwise.” But then, what is the problem here? I believe that this and many other contemporary scientists are overinterpreting the constructivist message. They are perceiving relativism where there is only relativity. Relativity may be disturbing to scientists, but it is not lethal. What scientists cannot accept is relativism.

RELATIVITY AND RELATIVISM

In most of its formulations, constructivism dwells in the realm of relativity. I use the term relativity in a philosophical sense that does not necessarily correspond to the original sense used by physicists. I say relativity because the central message is that scientific practices and scientific knowledge are not absolute; instead, they are relative to the context (usually, cultural context) in which they occur. Sure, this means that science does not have the type of objectivity that early positivists told us to expect (and Kuhn allowed us to retain). It also means that we can never attain absolute knowledge of the natural world, because the natural world does not exist (every world is relative to the context of inquiry). But, do scientists really care about a Platonic world of ideas or a Kantian world of things-in-themselves? I think not. If scientific inquiry is kept separate from metaphysical religious assumptions (21), there is no room in science for conjectures about the ultimate reality of the world. Science is concerned with the world we live in (as constructed as it may be) and not with an imaginary world of immutable beings. Albert Einstein, the man who brought the word relativity to the headlines, was not a philosophical relativist but did not hesitate to recognize that “the only justification for our concepts and system of concepts is that they serve to represent the complex of our experiences; beyond this they have no legitimacy” (6).

Now, one of the distinguishing features of philosophical relativity (as opposed to relativism) is the acknowledgement that, if “everything is relative,” then “everything is absolute.” That is, when we say that statement A is relative to context B, we are saying not only that statement A may not be true in context C but also that it is absolute in context B. This form of “arbitrary absolute” is just as absolute as it is arbitrary (relative). It is the absolute side of it that scientists truly care about. The relative side belongs to metaphysics, an area of inquiry that scientists are glad to leave in the hands of philosophers. As far as physics is concerned, the velocity of light is 299,792,458 meters per second. As far as physiology is concerned, fever is associated with a transient elevation of the thermoregulatory set point. We simply do not care whether Plato thought that the concept of set point existed as an essence in the world of ideas. Maybe, if we lived in a different world, if our bodies were shaped differently, if our culture were organized differently, scientific truths might also be different. This possibility is intellectually exciting, and we are glad that there are artists and philosophers exploring it. But, as scientists, our interests lie somewhere else.

It may be helpful to remember that constructivism is not at all the first expression of philosophical relativity. Heraclitus and other Greek philosophers explored
the theme of relativity some 2,500 years ago (9), and scientists have not been bothered by it. Why should we be bothered by elaborations on the same theme conducted by contemporary constructivists?

**EXCEPTIONS**

In fairness to scientists, I must acknowledge that the conflict between scientists and constructivists is not due exclusively to the scientists’ failure to understand the meaning of relativity. In some instances, it is the constructivists, not the scientists, who corrupt relativity into relativism. I will describe one example briefly.

A distinctive feature of relativism is the development of incomplete relativizations. Thus one points out that statement A is not absolute (i.e., that it is relative to context B) and then proposes that statement C should replace it. Naturally, if “everything is relative,” then statement C cannot be absolute either. Claiming that “statement C should replace statement A because statement A is relative” is a veiled strategy to bring back the absolutist perspective of positivism under the disguise of relativity. This version of relativism can be found in some forms of feminism.

I chose to use an example from feminism for several reasons. First, because feminism is a truly innovative intellectual movement, which Fuller very appropriately called “the final frontier” in postmodernist thought (8). Second, because scientists’ objections to constructivism often present feminism as a major culprit (18). Third, because Ruth Bleier, a feminist author, explicitly deals with biological sciences (2). In a refreshing relativist coup, Bleier put in question the dualist logic that has dominated the human civilization for millennia (2). Although most of us usually do not think about it, our civilization is strongly dominated by a dualist logic that is reflected in numerous dichotomies, such as nature-nurture, good-evil, male-female, and yes-no. What if we had adopted a different logic? How different would our culture and our world be? In examining these questions, Bleier does a beautiful work of philosophical relativity. Or does she? Actually, to support the feminist agenda of women’s empowerment, she was forced to corrupt relativity into relativism. Thus, after a beautiful job of showing the relativity of dichotomous reasoning, she went on to state that this type of reasoning has been detrimental to science and should be replaced (2). Why the should? In a relativistic universe, one position is just as defensible as any other! Saying that one position is relative does not make the alternative position absolute. Certainly, she could (and did) claim that the dichotomous reasoning favors men. But then, nondichotomous reasoning would probably favor women, and we would be back in the issue of favoring one arbitrary choice over another. Cassandra Pinnick saw a similar form of relativism in the feminist epistemology of Sandra Harding: “It becomes inconsistent for her to say, on the one hand, that every epistemology is a tool of the power elite and at the same time maintain that a particular epistemology, feminist standpoint, will generate ‘less distorted’ methods and beliefs” (25).

This is not the place to discuss the political agenda of feminism and, consequently, I will not address the issue of whether Belier (or Harding) had a good reason to corrupt relativity into relativism. Considering that almost three-fourths of the faculty in American research universities is made up of men (12) and that the affirmative action movement that helped install women’s studies departments in most university campuses is currently under attack (4), one can understand the animosity of academic scientists against feminism. However, it would be a mistake to discard excellent works of philosophical relativity only because their integrity was corrupted by political action. After all, one could claim that placing logical coherence above political action is actually a deceptive male strategy to prevent the empowerment of women.

**CONCLUSION**

The conflict between scientists and philosophers of science (more exactly, constructivists) is not as insurmountable as some scientists think (11, 16, 28). On one hand, scientists must be aware of the distinction between relativity and relativism so they do not feel threatened by relativist philosophies. On the other hand, constructivists must also beware of the corruption of relativity into relativism. In particular, if constructivists expect scientists to accept the relativity of the scientific enterprise, they should be prepared to accept the relativity of their own enterprise (30). With a small dose of mutual understanding, the groups can coexist peacefully.
I started this essay by pointing out that postmodernist philosophy of science had become an informal part of the education of young scientists. I also pointed out that recent developments (specifically, constructivism) had caused many scientists to despise postmodernist thought. Having shown that, in many cases, postmodernism is not a threat to the scientific enterprise, I hope I have convinced scientists to allow postmodernist theories to permeate into science and to remain an informal part of science education.

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