Letters

Student-Teacher Interaction

Philip Abelson's editorial (3 Mar., p. 947) accuses the government of meddling in higher education because its cutback of fellowship funding is allegedly hitting the "Cartter" schools harder than others—not because its earlier policies encouraged an untenable expansion of graduate programs. He further suggests that it is in these prestige schools that students receive "good training and the stimulus of interaction with a sufficiently large group (critical mass) of their peers."

Many students have chosen to do their graduate work at "Cartter" schools because in the past the prestige has guaranteed them a good job. It is their misfortune, and ours, that past federal funding, together with prestige-seeking publish-or-perish policies (and professors) encouraged such large research groups that graduate students have, indeed, often been trained by their fellow students and by postdoctoral students. It is a pity that so many have not been educated through close interaction with a mature investigator. Some of these former apprentices to apprentices are obtaining positions in "un-Carttered" institutions, and the more adaptable are transcending their often useless technical expertise and educating themselves under the stimulus of contact with students and colleagues outside their often narrow specialty. Hopefully this will encourage cross-disciplinary endeavors, and widespread federal support at moderate levels will enable these young faculty and their colleagues to truly educate small groups of budding scientists.

John Walsh's report (News and Comment, 3 Mar., p. 973) points out that the research excellence of the little Carlsberg Laboratory has clearly depended upon the leadership of a few investigators like Lang, who interacted closely enough with his postdoctoral students to "turn a good idea into a terrific idea." The same kind of interactions that produce good science at the postdoctoral level, and at the undergraduate level, can be expected to produce it at the doctoral level as well. The inexperienced want and need close contact with an experienced and creative investigator, one whose judgments they can see in the making and compare with their own. The really critical "critical mass" in university science at all levels is that of one human mind, the mind of a creative scientist desiring to work closely with a few of his fellow men.

Congress would do well to insist that federal fellowship funds be denied university investigators whose research groups comprise more than a very small number of people—a number small enough to ensure that each student in the group receives several hours of personal attention from the faculty member each week.

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The Uses of Knowledge

In his article "Can science survive in the modern age?" (1 Oct. 1971, p. 21), Harvey Brooks describes an "extreme view" which "argues that new knowledge can always be more readily used by those with political and economic power, therefore knowledge inevitably leads to concentration of power and is thus inherently evil, at least in the present arrangements of society."

From the general tenor of Brooks's article, I assume that he does not accept this "extreme" argument, yet having raised it, he nowhere attempts to refute it. Is his silence the silence of assent? Does he accept this proposition as self-evident (which it seems to me it indeed is)? If not, perhaps Brooks will provide us with two or three nontrivial examples of new knowledge in the 20th century that has resulted in the equalization of power between the possessing and the nonpossessing nations, or between those who own the means of production and those who labor for them or are unemployed. If no such examples exist, if new knowledge leads "inevitably" (Brooks's word) to the further concentration of power in the hands of the powerful, what is the meaning of the distinction between knowledge and the use of knowledge that Brooks and other liberal commentators are at such pains to draw? If the concentration of power is really the inevitable consequence of science, then what is the meaning, except in some curious metaphysical sense, of the "neutrality" of science? Why should we distinguish science from its effects, if those effects are "inevitable"? Is the pursuit of new knowledge, irrespective of its social consequences, a *religious* value, transcending mere earthly suffering, a good in itself? If that is all the excuse that science can offer for itself, it will be swept away by the suffering indignation of its human sacrifices.

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Brooks states that since the scientific revolution, every political revolution in the West has attempted to ally itself with science. However, this is not the case; the Nazi revolution of 1933 in Germany was extremely antiscientific and antirational, and many people were intoxicated with its criminal attitude. The consequences are well known. The only way out of the present situation is to come to a real and honest synthesis between "the new social priorities" and modern science, including modern fundamental science not "relevant to society."

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Lewontin is quite right in assuming that I rejected the extreme argument he appears to regard as self-evident. In fact I assumed that the argument was so self-evidently absurd as to not require explicit refutation, or even serious discussion, certainly to a scientific audience. In any event, silence on my part was not intended to imply assent.

Implicit in Lewontin's letter is an assumption that we are dealing with a zero-sum game in which every scientific

advance increases the power, freedom, or wealth of one group at the expense of others. My own view is that the principal effect of the scientific revolution, especially in the 20th century, has been to change the nature of the social and economic game from a zero-sum one to a situation where many can benefit without cost to others. We are gradually moving from an economy of scarcity, inevitably based on exploitation of the many by the few, to a society of abundance, in which for the most part the exploitation of one group by another does not pay, even for the exploiter.

There is little evidence to support the proposition that inequalities are growing in the modern world, either within the developed nations, or between developed and underdeveloped regions. In the words of Carl Kaysen (*1*), "Economic history shows that, after the early stages of urbanization and the development of commerce, economic growth has tended to greater equality of incomes, both within nations and between them." In the United States, relative income distribution, after some equalization during World War II, has remained stable with a slightly equalizing tendency, and this has apparently been true in most industrial countries, including the Soviet Union. The relative income gap between the developed and underdeveloped countries has been closing slightly, although this is often disputed. It is true that absolute gaps have been increasing as the world economy grows, and this has frequently enhanced the perception of deprivation, especially under the impact of modern communications and personal mobility.

Most fundamental knowledge has been neutral with respect to the distribution of power and wealth. Certainly it has helped to bring wealth and power to some who started from a position of little power, and acquired it through exploitation of fundamental knowledge for the fulfillment of some human need or demand. Such a development cannot really be characterized as either equalizing or nonequalizing in its net social effect. In general, during the last two generations, the advance of knowledge has enabled many people to advance from working-class status to professional and technical occupations which offer greater freedom and self-fulfillment. In the last 25 years, the number of such careers has increased three times as fast as the total number of jobs of all kinds. Yet it is difficult to describe such a social change in terms of equality or inequality. Even for the hourly worker, the 40-hour week has surely increased options, as has the disappearance of diseases such as diphtheria, smallpox, and polio or the decline of diseases such as tuberculosis, malaria, and pellagra. Perhaps Lewontin regards these examples as "trivial" or as inapplicable because they have not punished the rich and powerful, even though they have improved the lot of most people.

The impact of modern communications illustrates the difficulty of meaningfully discussing the impact of modern science in terms of equalizing or amplifying differences in power. On the one hand, communications and air transportation have played an important part in raising the political consciousness of disenfranchised groups in developed societies and in raising the aspirations of the underdeveloped countries, as well as their actual influence in worldwide deliberative bodies such as the United Nations. It is quite true that all over the world sights have been raised much faster than actual improvement in the conditions of life, thus creating frustration and a perception of decline in power of the powerless. Improvements in the lot of the poor have fallen shorter of expectations than in the past, not because these improvements have been trivial, but because the expectations have been much higher, largely as a result of the vistas opened by the freer circulation of knowledge in the world.

Furthermore, the telephone, television, and cheap copying have made it possible for underprivileged groups to organize politically (or be organized by others), and to make their expectations and demands heard in the national and international political arena for the first time. During the past dozen years minority groups in the United States have made more political and economic progress relative to the general population than at any time in American history, as has been amply documented by studies of family income, health, job access, and other indicators. It is painfully true that poverty is still with us, and seems more intolerable than ever in the past, precisely because we now know that modern science makes it unnecessary. But should we blame modern social science for creating and perpetuating inequalities and injustice in our society, or should we praise it for documenting them and making them incontrovertibly visible for all to see?

In reply to Plaut's letter, I think the difference between us is largely semantic. I would have classified the Nazi revolution as a counterrevolution, basically atavistic and reactionary from a cultural viewpoint. Hence I was not thinking of the Nazis in my generalization.

However, even if one were to accept Nazism as revolutionary, I would argue that it leaned heavily on the authority of science to acquire credibility in the eyes of its constituency and the German intellectual community. That the science appealed to was a distorted and discredited pseudoscience from the 19th century does not alter the fact that the regime found it advantageous to don the mantle of scientific authority to justify even its worst crimes. Mass murder was raised to a high point of technological efficiency, and the murderers prided themselves on the fact that it was all done very scientifically.

It is true that the Nazis attacked modern physics and largely dismantled the great German scholarly enterprise. But these attacks were not so much on science as such, as they were an effort to discredit authentic science in order to set in its place the pseudoscience required to justify the regime. The fact remains that the Nazi revolution purported to be based on science and did not attack the scientific method of knowing as such, unlike the situation with the modern counterculture.

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Reference

1. C. Kaysen, *Foreign Aff.* **50**, 666 (1972).

DDT Toxicology

Samuel S. Epstein, testifying before the Environmental Protection Agency on behalf of the Environmental Defense Fund (Point of View, 11 Feb., p. 610), makes a seemingly all-inclusive denunciation of "The current practice of toxicology," describing it as "an excessively insensitive and crude procedure." He states, without making exceptions, that "Animal test systems, quite apart from being grossly insensitive as a function of sample size, are hopelessly artificial in their design." But, on the basis of animal experiments, he states positively that, in his opinion, man cannot be