

Public Education for Science and Technology

What is the role that the universities should play in dispelling popular myths about science?

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The mid-20th century may be called an age of science not because all men are scientists or because all men understand science but rather because the forces unleashed by science are incomparably powerful. The lack of understanding between those who can call themselves scientists and those who only see the effects of science has become a dangerous schism even in the English-speaking world, which conducts a more than proportional share of scientific research. Ever since the advent of universal literacy and free public schools, it has seemed reasonable to expect that the educational system itself should provide every citizen with some understanding of science. Yet the present scene easily confounds such an easy belief. The school system has left many citizens sadly confused concerning the nature and significance of science. "Public education in science" is used here as distinct from the efforts of the school system proper and as supplementary to them. Hence, public education must take into account the great and growing gap between the accomplishments of science and the understanding of their significance by citizens at large.

The people of the English-speaking world of the 19th century had fewer doubts about the desirability or the possibility of public education in science. Their enthusiasm was a part of their belief in universal education, and their goal included science as a part of respectable culture. The lyceum and the workingman's institute not only included science but gloried in it. Outstanding scientists such as Sir Charles Lyell considered public lecturing a natural part of their proper role. In America, Benjamin Silliman and Louis Agassiz looked upon the lecture podium as a

place of opportunity equal to the laboratory and the classroom. And T. H. Huxley, one of the greatest molders of scientific opinion in history, worked out many of his most effective essays not in learned journals but before audiences of workingmen. Indeed, Huxley's "On a piece of chalk" and other lay sermons are still dominant models for the popularization of science.

The audiences of the middle 19th century responded with equal enthusiasm. The crowd in Boston which broke a plate-glass window at the Old Corner Bookstore trying to get tickets for a Lowell Institute lecture is not easily duplicated in 20th-century America. And the audiences flocked in to hear the straight science of the day. Many a lyceum lecture was a direct transplantation of a section of a college textbook. Amos Eaton, the great impresario of science in New York State in the 1820's and 1830's, gave chemistry demonstrations to the New York legislature. Both scientist and audience shared a belief that the common man could understand science, that the professional had a duty to explain science to the public, and that a massive uplift in society would result from their joint activities.

Twentieth-Century Phenomena

To understand the predicament of the university in the mid-20th century, one must examine what happened to the 19th-century faith in public education in science. To say that a scientific revolution has taken place is too trite. Instead, let us point to three obvious and major phenomena which have accompanied that revolution. In the first place,

science has become complex far beyond the comprehension of any one mind, professional or lay. Specialization has made possible the esoteric development of hundreds of lines of thought and research, to the point where acquiring an initiate's knowledge of any one of them is impossible for all but an infinitesimal proportion of the whole body of citizenry. The pessimism engendered by this complexity has led both the audience and scientists of the stature of Huxley and Agassiz largely to withdraw from the arena of public education.

In the second place, science has lost its place as a part of genteel culture and has emerged instead as the partner of technology. Until it was coupled with science, technology was largely a stabilizing factor in society, a brake upon change. When in the late 19th century it became coupled with science in a regular, continuous, and institutionalized partnership, technology reversed its historic role and became the major disruptive force as well as a major creative force in every Western society. People sensed rather than understood that science had something to do with this outburst of technological power, and in general leaped to a disastrous assumption which confuses the public today—the belief that science and technology are identical. This confusion led much public education in science, from the 1920's onward, to take the form of pointing in wonder at the end products of technology. If you would teach a student about science, show him a motorcar. The familiar will eventually lead to the unfamiliar, and the principles of mechanics, of combustion, and of expansion of gases are all accessible by this route in a miscellaneous array. Also, unfortunately, many citizens have drawn from this method of education the impression that high among the ranks of American scientists stands Henry Ford.

In the third place, a combination of the first two trends has produced a situation in which the guild of qualified scientists is completely unable to man all the posts in society which require an understanding of science. Each major application of science to technology brings large segments of society into a working relation with the scientific establishment. To give just one example, radar in 1937 was almost exclusively in the hands of guild scientists in research laboratories. Yet by early 1945, when the Fifth Fleet concentrated at Ulithi

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Atoll, half a world away from M.I.T., the forest of antennas implied that thousands of men of all ranks and rates had been forced to acquire some understanding of the principles of radar. This thousandfold increase was not accomplished by putting Ph.D.'s on every mine sweeper and patrol plane, but rather by forced and fragmentary education in science of large occupational groups which theretofore had been largely innocent of electronics. Since World War II the impact of science on new groups has continued to increase. Labor leaders, business executives, and stockbrokers are increasingly enmeshed. And most of all, the statesmen and politicians and civil servants find themselves deep in questions of science polity, regardless of their backgrounds. And as a complement to this involvement, the scientists find their affairs less and less the subject of guild determination and more and more in the hands of those outside the guild who are concerned with larger questions of policy.

These three trends have paradoxical effects. They remove the common man from any possibility of understanding science at its highest level, while at the same time they enmesh more common men directly in the affairs of science. They make the common man feel science all around him with the flood of technological end products, thereby obscuring the distinctive role that science plays independent of its technological applications. Perhaps the only clear impression which emerges is the inadequacy of the 19th-century pattern of public education in science. The one approach that gives least promise of success is the 19th-century effort to make every man a scientist by giving him a lecture at a lyceum. Yet the pessimism here implied is matched by the heightened sense that civilization must not be allowed to fragment itself without a protest on the part of the universities. One way to get a more realistic appraisal of the problem facing us is to do away with the formidable task of providing public education for the common man and to break him down into distinct audiences created by the trends we have already mentioned.

The Cargo Cult

The habit of approaching science by way of technological end products produces an audience held in thrall by what we may call, by loose analogy from anthropology, a cargo cult. When

in World War II the natives of Melanesia beheld the terrible and wonderful end products of Western technology coming ashore as cargo from the fleets of ships, they could see neither the industrial system nor the pattern of ideas which produced these unimagined riches. Their reaction, however, was based both on close observation and on cause-and-effect reasoning. The white men who possessed the cargo engaged in mysterious paper-passing rituals and erected feathery metal monuments to their gods, with whom those who possessed the secret of the cargo could communicate, thus bringing more ships and more cargo. By grafting these observations onto stories of a messiah, as half-understood from missionaries, and onto assorted native myths, the islanders were soon seized with the millennial ecstasy of the cargo cult. They stopped work, neglected their tribal customs, and built bamboo antennas on their huts in order to communicate with the new messiah who would bring the cargo to them!

Without pressing the analogy too far, one can nevertheless assert that a cargo cult exists in American society itself. Many of the symbols of science in the public mind are no more functional parts of the scientific enterprise than are the bamboo antennas of the Melanesians. Scientists appear as white-coated witch doctors manipulating the mysteries of an esoteric cult. The public, failing to understand science, nevertheless worships it as a messiah while fearing its diabolical power. Technological marvels, called science by the cults, add to their undeniable power by corroding the fabric of society with the false hope of an immediate millennium.

The universities, which are among the few institutions in American society possessing the resources to describe the whole process from basic science to technological end product, have a positive duty to discourage the cargo cults. Any program of public education to which they subscribe must make clear the difference between science and the artifacts of technology. And the universities must not delude themselves into thinking that by taking no action they can merely leave the citizenry innocent of science. The cargo cults are already loose among the people, batten on the stereotypes fed by mass communication media. The longer the inaction lasts, the firmer will be the hold of the cargo cults and the harder it will be to dispel the mysteries surrounding science.

Two Audiences

In this framework, the university can begin to identify one large audience to whom it has something to say about science. A large group of people of all levels of education and of all social classes emerge from school and college knowing so little science that they are ripe for the cargo cults. The universities cannot dream of recruiting scientists from this group, nor can they dream of making every voter his own scientist by serving freshman courses to the public. What they can perhaps do is give this group a sense of how science deals with problems. If each person can be led to think about one problem as the scientist thinks about it, he will be much less likely to make the confusion of ends and means which lies at the base of the cargo cult. Since much scientific thinking does go on in a university, the university is a proper and even necessary agency for telling the public how a scientist uses his mind, and for showing that in any given situation scientific reasoning is not mystery but its opposite.

Too much dissatisfaction with the teaching of science at all levels exists to make the design of a program of public education in science for this first and largest audience an easy task. As much as a quarter of a century ago C. P. Snow had a scientist in one of his novels rail against the logical method of teaching science and regret his own miseducation.

Others have seen the inhuman and lifeless form that is left when the path of science becomes inexorable logic. Their remedy is usually to present science as a form of history. Recount, they say, the wayward course that science has actually taken in order to grasp the life of the enterprise. Then one may fathom the unpredictability and excitement of research. The universities should consider carefully whether this is a real way out.

Even if the great mass of people who misunderstand the nature of science could be brought to a state of appreciation, however, the universities would still feel the need for a program of public education. For another large and growing audience has a different and even more pressing problem. The army of technicians, administrators, military men, and philosophers who have recently come within the umbra of science are sufficiently versed in some form of science to avoid the grosser obscurities of the cargo cults. But they desperately

need to understand science as a social and institutional expression of a tradition of which they themselves are not a part. The social relations of science are no longer merely internal, within a closed guild. They are a fundamental part of the policy of a nation and of the international community. The audience of people within the umbra of science consider science not so much a system of ideas about nature as a social activity among men. Many in this audience are in command of sophisticated bodies of scientific information. Many of them, however, have only outworn slogans with which to analyze the changing role of science in society. Can any public servant do his job today without some appreciation of the changed relation of the government and science? Can any business executive make adequate decisions without some appreciation of the role of the industrial research laboratory? Can any university official operate today on the assumption that he has no scientific connections with the government and industry? Is any military or diplomatic problem understandable apart from the scientific problem that is involved? These questions involve political, social, and economic

issues in society as a whole. And on their resolution could depend survival itself.

The ability of the rich and varied empires of science to mount a program of public education may be open to question, but a glance at any American university's resources for studying science as social activity reveals only appalling weakness. Despite the hundreds of scientists on its faculty, a university can usually count the scholars working on the social relations of science on the fingers of one, or at most two, hands. And even these scholars are scattered through several departments of the humanities and social sciences and are out of touch with one another, distracted by other interests and demanding duties. Would not a public education program in science as a social activity only reveal to the world the scandalous neglect of this subject by the universities? Possibly so. But there is a surprising amount of literature, written in at least passably plain English, stacking up in this area, which might provide a sufficient basis for discussion. One cannot conceive of didactic teaching on the basis of present knowledge. But a body of information does exist, at least

enough for interested people to ponder. It is the importance of the questions, not the availability of answers, that bids people attend. If this were not so, how could international affairs and the cold war have any place in public education?

In summary, the trends in 20th-century science sketched here call for the universities to mount not one but at least two programs in public education in science. The first must be designed for an audience that does not know what a scientist does or how he thinks or solves a problem. The second must be for an audience already in touch with science and challenged by that very fact to understand it as a social activity. In neither case does the university possess the manpower to man the programs directly. Rather, it must decide whether these programs can be carried out indirectly, through techniques of public education developed in other fields. Above all, however, the universities must not, in their preoccupation with the difficulties of doing anything in public education, forget the price they will pay if they do nothing. Misunderstanding science and its role in civilization levies a toll on all mankind.

Science and the News

As Interpreter of Soviet Moves, Khrushchev Remains the Best Kremlinologist

For those whose job it is to explain the Khrushchev Effect, the last 2 weeks have been busy ones, indeed.

Without so much as stumbling, Khrushchev has ordered Soviet test resumption; demanded a settlement of the "German problem"; scoffed at the neutrals; caused the United States to resume nuclear testing; and rejected an appeal for an atmospheric test ban.

At the same time, the French agreed to U.S. nuclear arms training for their

troops; Congress acted favorably on a permanent U.S. disarmament agency; a badly mauled foreign-aid bill was authorized; and the Geneva test-ban talks were indefinitely postponed after 340 sessions.

Meanwhile, intrepid Soviet and U.S. scientists met in the sylvan tranquillity of Vermont to discuss mutual interests; Eastern and Western scientific confreres met in Vienna to exchange data on fusion research; U.S. disarmament negotiator John J. McCloy met with Valerian A. Zorin to plan a general disarmament conference; and the nettlesome Jack Parr upstaged two colonels,

a lieutenant colonel, a major, a captain, two lieutenants, and a platoon of enlisted men in Berlin.

At best, attempts from beyond Red Square to explain all the actions and reactions that result from the Khrushchev Effect are conjectural. Clearly, the best Kremlinologist is Nikita S. Khrushchev. In recent weeks he has repeatedly spelled out his plot. He is authoring an anatomy of terror. And, for the moment, at least, he seems to be succeeding.

Khrushchev wants two Germanys and an independent Berlin. Although he is willing to subject his demands to a second Kennedy-Khrushchev confrontation—and there could very well be an East-West summit meeting soon—most observers agree that Khrushchev would remain intractable in his demands. In this, Khrushchev mimics the World War II aphorism that there is a right way, a wrong way, and the Army way of doing things. To settle the Berlin crisis, there is only the Khrushchev way, in Khrushchev's view.

The Soviet resumption of nuclear testing is inextricably linked to the