The Humanization of Science

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Scientific Knowledge and its Social Problems
Jerome R. Ravetz. Oxford, England: Clarendon Press, 1971. $17.00. 449pp.

As knowledge changes, so does the process of education. And further, with each substantial change in our idea of the knower and the known, with each transformation in the ruling answer to Spencer's query—"What knowledge is of most worth?"—educational policies up and down the line become ripe for reform.

In recent years we have heard a great clamor for reform, for the open classroom and the soft revolution, for the counter-culture and the dissenting academy, for radical caucuses and the new professional, for restructuring the university and deschooling society. But despite their protestations, the reformers have rarely been radical; rarely have they gone to the root. Instead they seem to stigmatize the status quo and to command willfully that the old crab apple tree try growing fruit, succulent, red, and delicious. The fruits of the old order rebuke this arrogance, an impass develops, and we are drawn into a passionate struggle over inconsequentials.

To use the jargon of the social sciences, the system—whatever it may be between technocracy and apocalypse—is always a dependent variable; in matters educational, the ruling epistemology is the independent, controlling variable. The great nineteenth-century transformation of educational institutions formed the basic physiognomy of our pedagogical status quo; and it resulted as the scientific conception of knowledge (a cumulative, progressive system of verifiable hypotheses about all aspects of experience) displaced the former conception characteristic of the gentlemanly professions, especially the cleric and the magistrate. With this shift, collegiate education in the "arts," with its emphasis on Latin, Greek, and Hebrew, on rhetoric and debate, and on a manageable, common culture for the upper classes, gave way to university instruction in the diverse disciplines, with its emphasis on the living languages and mathematics, on the techniques of research, on getting and keeping abreast of one or another specialty.

Whatever the prestige of scientific knowledge, the university system, and all that leads into it, is not dependent on some eternal Platonic form of knowing, from which any deviation can *a priori* be defined as degradation. Rather the present system is dependent on an historic form of knowing, one profoundly conditioned by the time and place in which the dream of natural science came to fruition. Historic change and metamorphosis in that form of knowing will be the real root of reform in the system. Hence, *Scientific Knowledge and its Social Problems*, Jerome R. Ravetz's major contribution to the history and philosophy of science, should be of interest to anyone concerned with change in education.

An historically informed philosophy of science has been developing through the work of men like Sir Karl Popper, Michael

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Polanyi, Thomas Kuhn, N. R. Hanson, and Derek J. de Sola Price. Ravetz's book is one of the most comprehensive contributions to this fast developing paradigm. Working with the benefit of hindsight, these scholars have taken as their authoritative sources, not what putative scientists proclaimed in prospect that they would or should do, but what working scientists proved in retrospect to have been doing. The resultant paradigm leaves largely intact the traditions of scientific accomplishment, but it considerably transforms our understanding of the process giving rise to those accomplishments, showing that it concerns not natural law but human theory, that it is conditioned by diverse value judgments, historical accidents, and social conditions, that it is liable, like all human works, to regress as well as progress. In short, the resultant paradigm makes of the old naturalism a new humanism.

In *Scientific Knowledge and its Social Problems*, Ravetz makes good use of his predecessors in the humanization of science. The author chose to relegate his discussion of examples to footnotes, which are sometimes overly compressed for easy comprehension by the layman and which sometimes leave the main argument seeming somewhat more general than perhaps it should. Nevertheless, the book has great authority. The author shows himself to be an historian of science in thorough command of his field, impressively so in the extent of his familiarity with the history of the various particular scientific disciplines. But more important than this thoroughness is the range of Ravetz's reach. He is well-grounded not only in the history of science, but also in the sociology of knowledge; Hannah Arendt, Joseph Ben-David, Norman Birnbaum, D. S. Greenburg, Paul Lazarsfeld, Karl Mannheim, R. K. Merton, C. Wright Mills, Robert Nisbet, Talcott Parsons, Max Scheler, Max Weber, and Florian Znaniecki figure in his important references. Finally, his philosophic background, while displaying limitations, goes beyond the philosophy of science, narrowly conceived, and he follows with facility a number of problems of epistemology and ethics back to their historic sources. Thus, substantively, it is a most impressive book.

Unfortunately, as a literary effort, the book has flaws. Ravetz's favorite encomium is "deep": in a two page span we read of a "deep" book, "deep new advances in mathematics," "obscurities at ever deeper levels," "deep and basic ideas," and "a deep attack on" obscurities. While Ravetz's book may properly be called deep, it makes difficult reading not for its depth, but for its breadth. Ravetz has linked three books into one; in doing so he confronts readers with an argument that will not easily be outflanked, but it may too easily be put down in a state of admiring exhaustion. In the middle there are two treatises, one a conceptual analysis of the nature of scientific knowledge, the other a sociological analysis of the conditions shaping scientific activity, primarily in the United States and Britain, during the post-war period. Before and after these, there are essays, much more popular in tone, that might well stand alone under a heading such as "The Past and Future of Present Science." But it is well worth persevering through these difficulties of form.

At the outset, Ravetz sums up well the main points in his analysis of scientific knowledge. "Scientific inquiry is a craft. The objects of this work are not natural things, but are intellectual constructs, studied through the investigation of problems. The work is guided and controlled by methods which are mainly informal and tacit, rather than public and explicit. The special character of achieved scientific knowledge is explained by the complex social processes of selection and transformation of the results of research."

In describing scientific inquiry as a craft, Ravetz shows how the working scientist must acquire through a kind of apprenticeship a feel for his work, learning how to produce data and assemble pertinent information, to manipulate both with subtle tools, physical and mental, to sense and

avoid the diverse pitfalls that can make those manipulations ineffective, to work masterfully with a set of tested techniques, and to do so preferably with a significant style. This craftsman's work is directed, not to nature itself, but to problems concerning "intellectually constructed things and events." The scientist's work is of the mind: his task is to find a difficulty in his cosmos of conceptions, to work out an argument with respect to it, to adduce evidence pertinent to it, and to come to a conclusion—a conclusion, remember, not about nature, but about his propositions.

To come to a conclusion—but what is that? It is not positive proof, that misguiding chimera. Rather, it is the position with respect to the argument and evidence that the community of scientific peers will judge to be adequate in view of their working values—their sense of significance, their rule of thumb for truth, their controlling purposes, be these enlightenment, human betterment, self-aggrandizement, or brute aggression. Over time, given a proper system of publicity, many of the conclusions that were at first judged adequate will nevertheless drop into desuetude, while others will, over and over again, be marshalled in further arguments, and these well-worked conclusions will take on the status of facts, to evolve slowly within the on-going scientific enterprise until perhaps some transformative argument alters the field and relegates the familiar fact to the realm of historic obsolescence.

What results from this process is determined neither by nature nor by truth, but by the historic character of the community of scientists, by their ruling values, skills, and craft. Hence, Ravetz's second, sociological analysis. In it he takes up a number of social problems that have arisen during the dynamic development of natural science, as well as certain contemporary difficulties that are at once social, intellectual, and ethical. Behind them all is the troublesome fact that healthy science, an enlightening, philanthropic science, will exist only insofar as the community of scientists judge effectively the adequacy of their conclusions, with the highest human values uppermost in their minds. Yet being human, all-too-human, the judging scientists can, for diverse reasons, displace these values and make their judgments according to one or another non-scientific, inhuman interest. Thus at any time the great question for the health of science is the place of value in a world of temptation.

During the eighteenth century, in order to lessen the temptations of self-interest, scientists had to devise an effective means to guarantee recognition of each worker's intellectual property in the fruits of his inquiries, or else the common pursuit would be plagued by a proclivity towards secrecy. This problem was solved by providing for the systematic publication of research reports and insisting that a common etiquette of citations be followed in these. With this system, the interest men had in winning personal recognition could work with, not against, the values of free and open communication.

During the nineteenth century, problems of controlling novelty arose, for as fields began to generate rather frequent and far-reaching innovations, it became possible that either authentic advances would be suppressed by entrenched leaders whose prestige was threatened or that uncontrolled innovation would disintegrate a field by breaking all patterns of continuity within it. This problem was solved by ensuring that each field could be pursued intensively by several different groups, each based at its own location and sustained by its independent resources. With such polycentrism, one school dominated by an established orthodoxy would provide continuity, while another one responsive to new views would encourage innovation.

During the twentieth century, as science has become affluent, capital intensive, in short, industrialized, the great problem—as yet unsolved—is quality control. Short cuts pay for both the genius and the journeyman. The system for publication and the etiquette of citations is no longer commensu-

rate to the scale of scientific practice, and the problems of information retrieval not only make difficulties for the pursuit of healthy work, but further create a confusion that is conducive to abuse. Both the state and industry have the resources to confer power and prestige on those whose criteria of judgment are quite different from those proper to their fields. "Under these conditions, the system of assignment of prestige, always a delicate and unstable thing at the best of times, cannot operate to any worthwhile effect. . . . The problem of quality control in science is thus at the centre of the social problems of industrialized science of the present period. If it fails to resolve this problem, and does not develop new techniques for restricting prestige and rewards to those who deserve them, then the immediate consequences for morale and recruitment will be serious; and those for the survival of science itself, grave."

At this point, Ravetz launches into the argument that, if generally judged adequate, will lead to fundamental reforms in education. A mere mechanism of quality control cannot work under the conditions of industrialized science. "No formal system of imposed penalties and rewards will guarantee the maintenance of quality, for the tasks of scientific inquiry are generally too subtle to be so crudely assessed; nor will the advantages to an individual of a good reputation of this group be sufficient to induce a self-interested individual to make sacrifices to maintain it." Consistent with the tenor of his argument throughout, Ravetz contends instead that the future health of science depends not on formal mechanisms, but on the free, ethical commitments of the working scientist.

"The health and vitality of scientific inquiry are not guaranteed, either by the objects of inquiry or by the social aspects of the work. Hence, unless there is an effective ethic, even more refined than a 'professional ethic,' this very delicate and sensitive work will not long continue to be well governed or well performed." Such an ethic, however, is not ready at hand. Both traditional religion and rationalist philosophy have been losing sway among scientists, and neither conduces precisely to the scientific ethic in its contemporary form. The gentleman scientist, with his unstudied, scholarly civility, is no longer the characteristic type in the society of industrialized science. "Therefore, the ethical basis of future excellence in science must lie in some other ideals and experience; perhaps in a humanitarian commitment, necessarily interpreted in a much more sophisticated fashion than ever before."

This "perhaps" is considerably reinforced as Ravetz proceeds to discuss, not the social problems of science itself, but the social entanglements of science with the world outside itself. "Science becomes directly involved with society at large when it is applied to the solution of technical problems, involving the production of the means for the performance of a function, or practical problems, involving the achievement of the purposes of individuals or groups of people." Such problems are so numerous and diverse that no man can really claim that his field is uninvolved: the "neutrality" of science is a defensive deception. But that said, one must add, as Ravetz does, that passing judgment on the commitments of scientists is no easy matter, no easier than with respect to the deeds of any powerful man of action. Action in any mode is tragically ambiguous, for its existential consequences are never known at the moment of commitment. Hence men, scientists included, will rightly differ over what is to be done.

Ravetz recognizes this human condition. He is not a puritan bent on imposing rectitude on a corrupt tradition. Scientists being first men, simony will be a common sin among the practitioners of industrial science. Hoping, not to eradicate the evil, but to limit it, he calls for the further development of "critical science." Critical science is arising out of an explicitly humanitarian commitment. This commitment is not new, but the way it is being pursued is. "Instead of isolated individuals sacrificing their

leisure and interrupting their regular research for engagement in practical problems, we now see the emergence of scientific schools of a new sort. In them, collaborative research of the highest quality is done, as part of practical projects involving the discovery, analysis, and criticism of the different sorts of damage inflicted on man and nature by runaway technology, followed by their public exposure and campaigns for their abolition."

In part, this idea of critical science can be seen as a legitimation of the peace movement and ecological movement, involvements which, Ravetz makes clear, were a significant stimulus to his thinking. But to leave it at that would be to invite the ill-disposed to dismiss it through an irrelevant argument from origins. Whatever the origin of the argument, its logic stems from the extensive evidence that science is a profoundly human enterprise, concerned with constructs of the human mind, advanced by human effort and imagination, endangered by human failings, inspired by human purposes. Ravetz sees in critical science something much greater than the legitimation of one or another contemporary movement.

> If the style of critical science, imposed by the very nature of its problems, becomes incorporated into a coherent philosophy of science, it will provide the basis for a transformation of scientific inquiry as deep as that which occurred in early modern Europe. The problems, the methods, and the objects of inquiry of a matured and coherent critical science will be very different from those of academic science or technology as they have developed up to now; and together they can provide a practical foundation for a new conception of humanity in its

> relations with itself and the rest of nature. . . . All this is work for the future; but if it is successful, the opposition between scientific knowledge and human concerns, characteristic of the sciences derived from the dehumanized natural philosophy of the seventeenth century, will be overcome.

As Ravetz says, all this is work for the future. But if this work is the future, then the future of our educational institutions will differ radically from their present.