[Editor's introduction: The following are excerpts from three talks given at the conference "Policies and Publics for Science and Technology," London, April 1990. They introduce a British research initiative in public understanding of science and point to early results. The program was developed and coordinated by the Science Policy Support Group.

At the meeting, a new journal for specialists in this area was launched: Public Understanding of Science, *to be edited by John Durant, Science Museum, London SW7 2DD, UK. The first issue of the journal is expected to appear in April 1991.*

Science, Technology, & Human Values *reaffirms its long commitment to publishing research on public attitudes toward science and particularly welcomes articles on this topic of general interest to the field of science and technology studies.]*

Public Understanding of Science

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Concern about the gap between the world of science and the world at large is nothing new. The British Association and other similar bodies were founded in the early nineteenth century to fill this gap. Many scientists of distinction have given of themselves to write, lecture, and broadcast to extend the "attentive public" for their work. Many talented writers and broadcasters have made it their business to explain in simple terms what the scientists were doing.

Nevertheless, there has long been a feeling that these efforts were not having much effect. It seemed a paradox that so many people should have so little understanding of the science that dominates their culture. They might find themselves quite unable to make any sense of important practical questions affecting their lives—small questions, such as the goodness of eggs; large questions, such as the safety of nuclear power. In fearful ignorance, they might even take against science altogether, heedlessly throwing out the baby with the bathwater.

These concerns came to a head in the report of the Royal Society Committee chaired by Dr. (now Sir) Walter Bodmer, which appeared in 1985. As a member of that committee, I can vouch for the thoroughness with which the subject was explored. We covered a great deal of ground, from the primary

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classroom to the corridors of power, and informed ourselves as best we could on past studies of the many issues that were raised.

But it was surprising to us how very little serious research had been done on the subject. We did not even have reliable estimates of scale factors, such as what proportion of the public know how much about what sort of science, let alone an understanding of personal factors such as attitudes or of social influences such as education or the media. Thus the plan for a major program of research to follow up on the Bodmer Report was widely welcomed.[1]

Originally, we broke the theme down into three types of question:

What do people say about science in general?
How do people use science?
How is scientific knowledge supplied and received?

In this introduction, I give an indication of the findings on the first. The other two contributions treat the second and third.

Overall, the most important finding of the research program is that "science" is not a well-bounded, coherent thing, capable of being more or less "understood." This finding is not in any sense a subversive attack on the marvelous and immense body of knowledge produced by scientists, engineers, physicians, technologists, and other researchers. Instead, it is a reminder that what counts as science is sometimes defined very differently by different people – or even by the same people under different circumstances.

Let me remind you that scientists themselves do not have a clear and consistent notion of what "science" covers and often disagree profoundly on what it is telling us about the world. To give some obvious examples, they are just as divided as the public at large on whether psychology is a "science," they still seem very uncertain about the biological evolution of the human species, and they offer patently contradictory "scientific" advice on healthy eating. In other words, "science" is not a sharply defined and special type of knowledge, which only starts to be misrepresented and misunderstood outside well-defined boundaries by people who simply do not know any better.

This does not mean that we should be complacent about the low level of basic scientific knowledge revealed by all public surveys, in this country and most others. It is quite clearly the responsibility of every scientifically literate person to combat the extreme ignorance of the most elementary scientific facts and theories that we find even among the best educated of our friends and colleagues. Every possible means should be taken to improve the transfer process in the science museum, in the schools, in the media, or wherever.

The fact is, however, that a simple "deficit" model, which tries to interpret the situation solely in terms of public ignorance or scientific illiteracy, does not provide an adequate analytical framework for many of the results of our research. In this program of research, we have seen many everyday questions that cannot be addressed properly, let alone answered, simply in terms of a shortfall in potential understanding. The significance of formal scientific knowledge in any particular situation depends vitally on a number of other factors that need to be brought into the analysis. The results coming out of the various projects cannot yet be interpreted coherently according to some more elaborate model that takes all the contextual factors into account, but it is fair to say that they are beginning to jell around a few broad principles:

Incoherence. People do not draw on stable, if fragmented or ill-conceived, "models" of the world, along the lines of textbook accounts of scientific knowledge. The little they retain of what they were taught at school is overlain and supplemented by the diverse representations of science that they meet in the media and in many other aspects of life. What they pick up is not simply a filtered version of formal scientific knowledge: its meaning is actively constructed by the processes and circumstances under which it is communicated and received.

Inadequacy. The use that people make of formal knowledge in any particular situation depends on the needs of the moment and represents only one element in a complex and varied response. They not only rely heavily on the tacit, uncodified, but highly expert and rational knowledge that is shared in most work communities: they also engage with, select, or construct the scientific elements according to their own interests, involvement, personal and social histories, and other circumstances.

Incredibility. People do not accept passively the knowledge presented to them by scientific "experts." The credibility of a source depends strongly on its perceived interests in a particular context. This applies to individual scientists, scientific institutions, public bodies, and private enterprises.

Inconsistency. Public conflicts on social issues between scientific experts inevitably downgrade the privileged position of scientific knowledge. But public and private discussion helps people combine their scientific knowledge, ethical views, and tacit understanding of life into personal positions on controversial matters. In effect, they resolve the contradictions that arise by

incorporating items of formal science into the whole knowledge complex and making them "disappear" as such.

These, in outline, are the principles that seem to govern the way people receive and use scientific knowledge. As Beethoven said of good music, they are both surprising and expected. They are surprising if you come to this subject straight out of the lecture hall and research laboratory. They are expected if you reflect on your own experience of everyday life, thought, and talk.

Qualitative results such as these need to be interpreted in terms of a properly scaled map. It is therefore essential to have some quantitative data about the social phenomenon they describe. Two projects in the research program provided such data.

The Oxford survey drew its sample from the whole adult population of Britain and was concerned with how much people knew about science, how interested they were in it, how well informed they thought they were, what sort of beliefs they had about it, and what their attitudes were toward it (Durant, Evans, and Thomas 1989). An important feature of this project was that it ran in parallel with a directly comparable national survey undertaken by Jon Miller, in the United States (National Science Board 1990). The Surrey research concentrated on young people (i.e., between the ages of eleven and sixteen) and their responses to scientific and technological change. It was thus concerned not only about their knowledge of science but also about their beliefs, attitudes, and involvement with science, actual and prospective.

The striking result of both surveys was, of course, how little grasp most adults seem to have of the most elementary items of scientific knowledge. There has already been wide publicity in the media for an average score of about eleven correct answers for a "quiz" of twenty questions—questions as simple as whether the earth goes around the sun or whether the earliest humans lived at the same time as the dinosaurs. It is interesting that the overall result was not really very different in the United States, although with some significant variations probably associated with other cultural factors such as religious attitudes.

As I have already emphasized, this degree of public ignorance is very distressing, indeed, and would seem to call for a very determined effort of education and reeducation, through formal schooling and the media. But this type of policy response attaches a great deal of weight to the weaknesses in people's formal scientific knowledge. It does not make allowances for the difference between respondents' tacit understanding of the state of affairs and their ability to state verbally what they know. One of the most instructive results of the Oxford survey was the contrast between the poor showing of

most people on direct questions about the nature of scientific inquiry and their excellent grasp of the practical logic of drug testing and of the inheritance of genetic defects. It cannot be assumed that their formal ignorance of science makes them quite unwise in their actions.

The deficiency model may also underestimate the problems of making people more scientifically literate. Both surveys show a positive correlation between knowing about science and being interested in it. Despite all the conjectures to the contrary, the great majority of respondents in the Oxford survey report themselves as "very interested" or "moderately interested" in news about discoveries and inventions—much more interested, in fact, than in news about sports, politics, or films. The paradox is that they also report themselves as worse informed about science and technology than about sports or politics. The other research in the program suggests that this general "interest," in the abstract, is likely to be much less influential than specific material "interests" in getting adults to understand science better.

Indeed, detailed analysis of the Oxford data shows clearly that general attitudes toward science as a whole are poor predictors of specific attitudes on particular science policy issues. Similarly, there is only a weak link between levels of understanding and general attitudes. The precise wording of general-attitude items is important, probably because many relatively uninterested and poorly informed respondents do not possess well-developed attitudes toward science at all. When more discriminating attitude measures are employed, it emerges that the better informed possess a generally more supportive view of science.

The relationship between understanding and specific attitudes is also complex. Understanding is associated with more support for obviously useful science—for example, developing new and more powerful computers—but with more opposition to morally contentious science, such as research on human embryos. Perhaps we should be cheered by the observation that people with greater levels of scientific understanding possess a more discriminating view of science: they distinguish more clearly between questions that are scientific and those that are not, and between scientific developments of which they approve, and those of which they do not. This is the sort of important point that surveys can reveal, and that they can be designed to explore in greater depth.

Both surveys are concerned about gender differences, and both report that males show significantly higher levels of knowledge, interest, and positive attitudes toward science than females do. This is an important general fact about public understanding of science, although perhaps very difficult to explore further by survey methods.

Nevertheless, the Surrey research showed up a more subtle difference that deserves further study. The analyses showed that certain characteristics differentiate between those young people who want a scientific job and those who do not. For both sexes, age, social status of father, and scientific knowledge are poor predictors of this choice. For young men, the effective predictors of wanting a scientific job are liking school, watching TV science, having higher educational aspirations, and feeling generally knowledgeable. For young women, on the other hand, the key predictors are attitudes. Women who do not want a scientific job are more likely to be cynical about the scientific establishment and to perceive sexual discrimination to operate in science.

The Surrey survey also threw up some very interesting information about the images that young people have of scientists. In general, scientists are often described as dedicated. But two other aspects are closely tied to the individual's attitude toward scientific change and the scientific establishment. Seeing scientists as antisocial is associated strongly with being cynical about the extent to which the public can control science and benefit from it. Feeling scientists are productive is allied to believing that the speed and substance of scientific change is good. There are obvious linkages here with the credibility principle that emerges from the more qualitative research.

Finally, the Surrey work takes account of the social context in which understanding of science is acquired or exercised. Attitudes toward science and involvement in scientific activities are both significantly correlated with parental encouragement—particularly with parental attitudes toward science—irrespective of the age, sex, or social status of the respondent. Attitudes of friends toward school, youth culture, and achievement also correlate with variation in both science attitudes and activity. As Brian Wynne and Roger Silverstone explain, this is entirely consistent with the general message of our research program—that scientific knowledge is not received impersonally, as the product of disembodied expertise, but comes as part of life, among real people, with real interests, in a real world.

Note

1. The program was funded by the U.K. Social and Economic Research Council and the Advisory Board for the Research Councils. There are eleven projects, one supported by British Gas.

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