3015

Science Writing and Literacy

fforum 4:2
(1983)

Grace Rueter and Thomas M. Dunn
English Composition Board
Department of Chemistry
The University of Michigan

One of the most important developments in education in the last decade--perhaps the most important--has been the enormous growth in the cultural and ethnic diversity of the student body and, indeed, of the programs offered in schools. This growth, accompanied by decreased homogeneity in all student groups, has been reflected in the broader base upon which many of the subjects, particularly those of an anthropological and cultural nature, have been considered. As might be expected, the concept of literacy itself has been broadened; but in most classes where reading and writing are taught, it has not been broadened to include science and its literature as part of the definition. It is not, perhaps, surprising that this should have happened since, traditionally, teaching functional literacy has been regarded as the province of the teachers of English and of English literature, and knowledge of science and its literature has not been one of their high priorities. If, however, students are to become fully literate, they must become familiar with the literature of science as well as the imaginative prose and poetry traditionally taught as literature. English teachers who want to help their students become literate today can and should introduce them to the literature of science.

As Jay Robinson suggests elsewhere in this issue of fforum, teaching imaginative literature exclusively is different from teaching literacy. Since literacy implies a capacity to understand ethics and culture in their broadest sense, the teaching of literacy requires the teaching of a plurality of literatures. Interestingly enough, this plurality was once encompassed by the word literature in its singular form, and it included writings in all areas of what are now classified as the humanities and sciences. Today, as the 21st century approaches, and as an understanding of scientific thought becomes increasingly important, English teachers who teach literatures have it in their power to lead students to a broadened appreciation of human experience in which the sciences and the humanities are reunited. We urge English teachers to begin the process of reintegrating the two traditions by including selections from the literature of science in their curricula.

Our purposes are to call attention to the neglected area of science literature and also, through examples which are not only good science but excellent writing, to begin to introduce non-scientists to the ideas and procedures of science itself. We believe the second objective is just as important as the first, and that it provides a way into modern science for those who have felt intimidated by its apparently formidable structures and technology. A large part of the intimidation has arisen from confusion in the public mind of what are, in fact, two distinct kinds of writings within the literature of science. We call them scientific writing and science writing, and they are clearly distinguished by the purposes, uses of language and different audiences for which they are intended. Scientific writing, the writing which appears in scientific journals, is written by scientists for an audience of peers to acquaint them with advances in their fields, and it bristles with the formalisms and abstract symbolisms on which the progress of many sciences depends. Science writing, on the other hand, appears in widely available books and essays and is written by scientists

for general audiences to make the concepts and methods of diverse areas of science accessible in everyday language. It is not scientific writing but science writing that can, and should, be included in English curricula.

There are, of course, important differences between science writing and imaginative literature. Perhaps the most important difference lies in the kinds of human experiences they treat. In an aesthetically pleasing essay which introduces readers to science, Aldous Huxley explores this difference:

> All our experiences are strictly private; but some experiences are less private than others. They are less private in the sense that, under similar conditions, most normal people will have similar experiences and, having had them, can be relied upon to interpret the spoken or written reports of such experiences in much the same way.
>
> About the more private of our experiences no such statements can be made. For example, the visual, auditory and olfactory experiences of a group of people watching the burning of a house are likely to be similar. Similar, too, are the intellectual experiences of those members of the group who make the effort to think logically about the causes of this particular fire and, in the light of current knowledge, of combustion in general. In other words, sense impressions and the processes of rational thought are experiences whose privacy is not too extreme to make them unsharable. But now let us consider the emotional experiences of our fire watchers. One member of the group may feel sexual excitement, another aesthetic pleasure, another horror and yet others human sympathy or inhuman and malicious glee. Such experiences, it is obvious, are radically unlike one another. In this sense they are more private than sense experiences and the intellectual experiences of logical thought.
>
> In the present context, science may be defined as a device for investigating, ordering and communicating the more public of human experiences. Less systematically, literature also deals with such public experiences. Its main concern, however, is with man's more private experiences, and with the interactions between the private worlds of sentient, self-conscious individuals and the public universes of "objective reality," logic, social conventions and the accumulated information currently available (pp. 4-5).

This passage immediately distinguishes for us in clear, beautifully structured prose, those things we might legitimately call science from those we might define in other terms, the most private of which we sometimes express in poetry. Aldous Huxley was a man of letters with the ideal scientific background to appreciate the private as well as the public experiences and to write about them with equal fervor and conviction. The quotation is the second of thirty-eight contributions in a small volume entitled Literature and Science, and Huxley's analytical treatment of the subject is scientific, perceptive and literate.

Recognizing that science and imaginative literature are grounded in different domains of experience, we must learn to understand and appreciate both. Studying science writing can facilitate the process for, as scientists have continued to publish books and essays for the public, the vast area of human experiences explored by science has become increasingly accessible to people whose primary interests are literary. As we all know, the realm of experience which imaginative literature treats, the realm of private experiences, is largely concerned with human interactions. In most of this literature, the environment, both animate and inanimate, if not simply taken for granted, either reflects those interactions in some way or is used as a backdrop for occasional sensual or colorful description. In the real world, there is no doubt that human relationships are

powerful determinants of both our courses of actions and our life styles, but the environment which surrounds and impinges on those relationships has a major effect on our behavior, our values, and our aesthetics. To be truly literate, we and our students must have total access, through reading and writing, to the physical and biological environments as well as the human relationships that shape our culture, our ethics, and the quality of our lives.

One of the problems faced by non-scientists who wish to extend their understanding of ethics and culture is where to begin, how to find a bridge from imaginative literature into science. The best science writing offers that bridge, since it shares much with imaginative literature. Teachers and students who read and enjoy imaginative literature can also read and enjoy science writing. Many of us have long marveled and often been exhilarated at the sense of beauty invoked by majestic phenomena such as waterfalls, mountains, clouds, sunrises and sunsets; this sense of marvel and exhilaration is deeply embedded in our cultural heritage and our imaginative literature. The intricate constructs of nuclear physics, chemistry or molecular biology, not perceivable to the naked eye, have the same capacity to thrill and to awe those who seek to "see" them.

Just as Huxley's elegant discussion of science and literature offers an introduction to the domain of science, so other science writings provide non-scientists with clearly-written, substantive expositions of the way science works. In the following piece, for example, from Science and Society--a collection of essays by authors as well known as Jacob Bronowski, James B. Conant, Erwin C. Schrodinger, Michael Polanyi and John Z. Young--Norman Campbell offers a strikingly lucid discussion of theories and laws in science. Campbell's essay, "The Explanation of Laws," speaks even more specifically than Huxley's to the distinctions between science and non-science and does so in a way which makes us feel the presence not only of a powerful intellect but also of a humane scientist:

> Explanation in general is the expression of an assertion in a more acceptable and satisfactory form. Thus if somebody speaks to us in a language we do not understand, either a foreign language or the technical language of some study or craft with which we are not familiar, we may ask him to explain his statement. And we shall receive the explanation for which we ask if he merely alters the form of his statement, so as to express it in terms with which we are familiar. The statement in its new form is more acceptable and more satisfactory, because now it evokes a definite response in our minds which we describe by saying that we understand the statement. Again we sometimes ask a man to explain his conduct; when we make such a demand we are ignorant, or pretending to be ignorant, of the motives which inspired his action. We shall feel that he has offered a complete explanation if he can show that his motives are such as habitually inspire our own actions, or, in other words, that his motives are familar to us (p. 41).

From this brief introduction, Campbell, a physicist, develops for non-scientists what is probably one of the clearest and most literate statements about theories and laws ever written. In only a few pages, he condenses for those who wish to read and seek new experiences what might have been expected to fill at least a volume devoted to critical thinking and symbolic logic. The ideas as well as the clarity and the economy of the language lure the reader to read on and on, further and further into what is normally regarded as an abstruse and academic topic, with understanding and pleasure.

Since science writing, like imaginative literature, is an attempt to make sense of human experience, it is not surprising that some of the familiar themes of great literature also run through science writ-

ing. These themes provide a context which helps non-scientists integrate unfamiliar ideas into familiar ones. The concept of "oneness," for example, of the interrelatedness of everything, a pervasive theme in imaginative literature, is also evident in science writing. The idea of relativity as developed by Einstein is an expression of this theme in terms of scientific events and metaphors. This theme recurs in the writing of many other scientists as well. It is, in fact, the thread that binds together the twenty-nine essays of Lewis Thomas' The Lives of a Cell. In these essays, Thomas, a biologist, draws on many of the familiar devices of imaginative literature while he explores and makes sense of the unfamiliar, as the introduction to the title piece shows:

> We are told that the trouble with Modern Man is that he has been trying to detach himself from nature. He sits in the topmost tiers of polymer, glass, and steel, dangling his pulsing legs, surveying at a distance the writhing life of the planet. In this scenario, Man comes on as a stupendous lethal force, and the earth is pictured as something delicate, like rising bubbles at the surface of a country pond, or flights of fragile birds.
>
> But it is illusion to think that there is anything fragile about the life of the earth; surely this is the toughest membrane imaginable in the universe, opaque to probability, impermeable to death. We are the delicate part, transient and vulnerable as cilia. Nor is it a new thing for man to invent an existence that he imagines to be above the rest of life; this has been his most consistent intellectual exertion down the millennia. As illusion, it has never worked out to his satisfaction in the past, any more than it does today. Man is embedded in nature (p. 3).

In this essay, Thomas expresses, almost as a conclusion to an argument not presented, the affirmation of the "oneness" of man and nature, an affirmation which seems to have almost the same ring and the same conviction as Beethoven's 9th Symphony. Through a myriad of unifying metaphors, Thomas makes significant scientific and social statements which encapsulate much of what we regard as important in the contemporary world; and these statements seem less didactic than beguiling because of the graciousness of their form.

As Thomas' essay suggests, much of the world of science is as metaphorical as the world of imaginative literature and, by necessity, writers must use the same language to express the great truths of both the public and the private domains. All of this is summed up very succinctly by Aldous Huxley in the final essay of Literature and Science:

> Words are few and can only be arranged in certain conventionally fixed ways; the counterpoint of unique events is infinitely wide and their succession indefinitely long. That the purified language of science, or even the richer purified language of literature should ever be adequate to the givenness of the world and of our experience is, in the very nature of things, impossible. Cheerfully accepting the fact, let us advance together, men of letters and men of science, further and further into the ever-expanding regions of the unknown (p. 118).

And, we might add, into the expanding literacy of the twenty-first century.

In the foregoing discussion we have cited only three of the many writers whose works we think are equally inviting to non-scientists but we hope that you have been sufficiently intrigued by them to consider doing further reading on your own. We conclude with a short annotated bibliography of selected science writings, those we have cited, along with a half-dozen others, which teachers and their students in English classes will find a useful bridge from imaginative literature into science. We have kept

the list short because we felt it should be manageable and also because we wanted to focus attention on books and essays which are reasonably accessible in school and city libraries. Furthermore, consciously drawing on materials written by active scientists, we have included selections which cover a wide scientific experience ranging from theories of scientific education through medicine and biology to physics because we hope to suggest at least some readings which will appeal to all tastes and interests. Finally, we would like to emphasize that this list is only a beginning. We see it as an appetizing hors d'oeuvre which may tempt teachers and students and sharpen their appetites for science writing in the quest for literacy.

BIBLIOGRAPHY

Bernstein, Jeremy. Science Observed: Essays Out of My Mind. NY: Basic Books, 1982.

Seventeen essays. Particularly recommended: "Nuclear Research," "Shooting the Pussycat," and "Furth's Reactor and Fusion." These three essays are an intelligent introduction to the advantages and problems of nuclear reactors and to their mythology. Also recommended: "Can TV Really Teach Science?"

Campbell, Norman. "The Explanation of Laws," Science and Society. Eds. Alexander Vavoulis and A. Wayne Colver. San Francisco: Holden-Day, 1966, pp. 41-48.

A short, strikingly lucid introduction to the concepts of theories and laws in science.

Dyson, Freeman. Disturbing the Universe. NY: Harper and Row, 1979.

The story of a scientifically creative life told by a humane scientist in a form easily readable by non-scientists. Particularly recommended: Chapters 1, 5, 8 and 9.

Eiseley, Loren. The Firmament of Time. NY: Atheneum, 1967.

Six lectures. These beautifully written essays direct one's thoughts toward nature and the mystery of human emergence while clarifying the role of the evolution of science in society. Particularly recommended: "How the World Became Natural."

Huxley, Aldous. Literature and Science. NY: Harper and Row, 1957.

Thirty-eight numbered essays. Probably the most literate account ever written of the relationship between science and literature and their similarities and distinctions. Particularly recommended: 1, 2, 3, 4 and 38.

Huxley, Julian. New Bottles for New Wine. NY: Harper and Row, 1957.

Thirteen essays on biologically-oriented science. Particularly recommended: "New Bottles for New Wine." A scientific yet all-embracing view of western scientific philosophy. Somewhat scholarly, but its subject matter is as valid now as when it was published.

Huxley, Thomas H. Science and Education: Essays. NY: D. Appleton and Company, 1910, Reprinted, Norwood Editions.

Seventeen essays. Particularly recommended: "On Science and Art in Relation to Education." Engagingly written by the "father of scientific education," this essay reminds us that relations between science and art have long been uneasy and that thoughtful people have long seen the value of bringing the two traditions together through education.

The Mystery of Matter. Ed. Louise B. Young. NY: Oxford University Press, 1965.

Particularly recommended: Part 11, "Is Science Destroyer or Creator?" Through a varied collection of writings from science and imaginative literature, this serves as a highly readable introduction to the philosophy of science and society and to the study of relationships between them.

Science and Society: Selected Essays. Eds. Alexander Vavoulis and A. Wayne Colver. San Francisco: Holden-Day, 1966.

Fifteen essays. A treasure trove of science writing by such superb and authoritative authors as Jacob Bronowski, John Z. Young, Erwin C. Schrodinger, Werner Heisenberg, and Ernest Cassierer. Particularly recommended: Norman Campbell's "The Explanation of Laws," Banesh Hoffmann's "Wave or Particle?" and Michael Polanyi's "Passion and Controversy in Science."

Thomas, Lewis. The Lives of a Cell: Notes of a Biology Watcher. NY: Viking Press, 1974.

Twenty-nine essays, all informative and delightful. As Joyce Carol Oates wrote in her review, "The Lives of a Cell anticipates the kind of writing that will appear more and more frequently as scientists take on the language of poetry in order to communicate human truth too mysterious for old fashioned common sense."

_____. The Medusa and the Snail: More Notes of a Biology Watcher. NY: Viking Press, 1979.

Twenty-nine essays. An engaging exposition, through short essays, on the beauties and surprises of the biological universe and its interrelationship with human beings.