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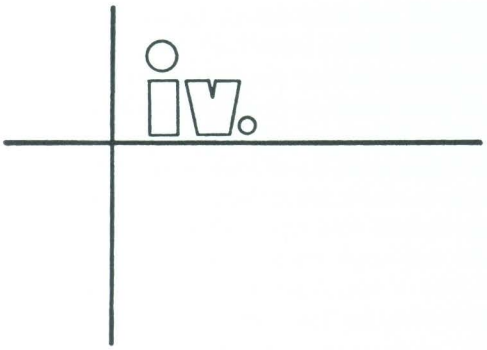

General Education Science for Citizens of An Open Society

By Don Weinshank

HOW SHALL WE TEACH GENERAL EDUCATION SCIENCE TO CITIZENS OF AN OPEN SOCIETY?

I want to argue that this question does not *have* an answer. More to the point, it does not have *an* answer, and any attempt to develop *a* general education science course for all citizens of an open society is doomed from the outset to be procrustean.

I regard a society as being "open" to the extent to which it not merely tolerates but actively facilitates the elaboration of intellectual pluralism.* But pluralism implies heterogeneity, and the image which I hold of the open society therefore resembles *pousse-café* more than mashed potatoes. I see the open society as being composed of many commingled but immiscible subcultures, richer for the constant interplay of ethnic and ideological themes of its member groups.

I shall briefly consider three conseqeunces of the pluralistic view of an open society. First, I want to look at the pluralism of the student body. Second, I shall examine the role of the instructor. Finally, I shall offer a model for curriculum development in a pluralistic (and therefore open) society. While this model is based on general education science, I would hope that you would see the applicability of the model to other fields of human endeavor.

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* (In the open society, for example, no idea can be regarded as intrinsically subversive of the established order.)

WHO ARE THE STUDENTS OF GENERAL EDUCATION SCIENCE IN AN OPEN SOCIETY?

In an open, pluralistic, heterogeneous society, students form a disparate mix for at least four basic reasons: prior education, prior experience, ethnicity, and cognitive skills.

PRIOR EDUCATION: This point hardly requires elaboration; the student, for example, who has had BSCS biology in high school simply has a much larger experiential base upon which I can draw in exploring with him the nature and implications of the scientific enterprise than the student who took a non-descript biology course from a teacher whose chief qualification for the task was that he was a losing coach.

PRIOR EXPERIENCE: This point is of considerable importance, although I shall not have time to consider it here in detail. We increasingly find older students in our classrooms, students who, for one reason or another, are returning to finish or even to begin for the first time educations which they were unable or unsuited to undertake at an earlier age. I refer you to the report of the MSU taskforce on lifelong education[1] and to other studies in this field.

ETHNICITY: This point I must consider in some detail. I want to argue that in any society, closed or open, people have as primary role-identifications membership in some small, definable, pseudo-speciated group. If you accept my analysis of this point, then Professor Popper's comparison of closed versus open societies is wide of the mark precisely because he underestimates the strength of ethnic and other societal groupings. He says,

> In what follows, the magical or tribal or collectivist society will also be called the *closed society*, and the society in which individuals are confronted with personal decisions, the *open society*. . . . A closed society resembles a herd or a tribe in being a semi-organic unit whose members are held together by semi-biological ties—kinship, living together, sharing common efforts, common dangers, common joys, and common distress. . . ."[2]

In an open society, Professor Popper does admit, "Men still form real groups and enter into real social contracts of all kinds, and try to satisfy their emotional social needs as well as they can."[2] Yet, if I am right about the strength and tenacity of subgroup identification, one of the *primary* questions which an instructor in the open society must ask is "What is my student-mix?". This question is a sort of intellectual demography. The SAT scores are the least of it! What I want to know is what world-views my students bring into our classroom, and whether they are open to conceding that their peers may see the world in very different ways for reasons which are, for them, good and sufficient.

COGNITIVE SKILLS: The last factor which increasingly makes

our student body inhomogeneous as we approach an open society is that different students have differing levels of cognitive skills. Professor Armstrong[3] discusses this problem in terms of four levels in a hierarchy of awareness through which a learner may pass: stereotypic, opinionate, existential, creative.

Stereotypic Learner: This student brings a fixed set of expectations, chiefly career expectations, with which to judge each course. Coursework appeals to him as relevant for an expected occupational role, which is often his parent's occupation or one designated for him by his parents.

Opinionate Learner: This is the student for whom all questions have dichotomous answers and for whom all knowledge can, in principle, be reduced to a set of correct and masterable formulations. Most of my students fit comfortably into this category. They find it unsettling that a real, live scientific question is one in which there may not be, at the present time, "one right answer."

Existential Learner: This is the student who sees himself in the here-and-now, rejecting both the past as irrelevant and the future as imponderable. A typical question I get from a level three learner is, "What's this shit all about?". In contrast to Dr. Armstrong, I have found these students to be among the most rewarding. Once I can begin to demonstrate that "this shit" is about the fundamental questions of how man sees himself as a person, as a part of the biosphere, and as a part of the universe, it is frequently the level three students who push me hardest and most critically to explore the relatedness of facts and concepts in general education science.

Creative Learner: This is the rare student for whom Professor Armstrong invokes Maslow's category of "self-actualization." One of mine, for example, wondered aloud whether Einstein's rejection of quantum mechanics as normative (that is, as opposed to merely descriptive) was related to his love of the Bach partitas. A term of very hard work, culminating in his writing to Helen Dukas, the curator of the Einstein archives, drew a complete blank. But the project was fun, and it was an intellectual treat to work with a creative student such as this one.

In summary of this section, then, general education science in an open society begins by evaluating the student-mix in terms of the four key parameters of prior education, prior experience, ethnicity, and cognitive skills.

WHAT ARE THE ROLES OF AN INSTRUCTOR IN GENERAL EDUCATION SCIENCE IN AN OPEN SOCIETY?

I see the general education science instructor in an open society as having three roles: evaluational, relational, and synthetic.

EVALUATIONAL: The first role of the instructor is to understand his students. The instructor fulfills this role to the extent that he understands and plans curriculum around the student mix he encounters.

RELATIONAL: We can understand the *relational* role of the instructor by reminding ourselves of precisely what Professor Dewey meant by "interest" in the context of pedagogy:

> When the place of interest in education is spoken of in a depreciatory way . . . interest is taken to mean merely the effect of an object upon personal advantage or disadvantage . . . these are reduced to mere personal states of pleasure or pain . . . The remedy is not in finding fault with the doctrine of interest . . . It is to discover objects and modes of action which are connected with present powers. The function of this material in engaging activity and carrying it on consistently and continuously *is* its interest. If the material operates in this way, there is no call either to hunt for devices which will make it interesting or to appeal to arbitrary, semi-coerced effort . . . The word suggests, etymologically, what is *between*—that which connects two things otherwise distant.[4]

"That which connects two things otherwise distant. . ." That is as good and beautiful a statement of the relational role of the instructor as any I have seen. Professor Bell speaks of "a new approach to science teaching as conceptual innovation, conceptions that involve scrutiny of the organizing principles of each discipline as an integral part of the discipline itself."[5] And, at another point, he says, "General education is education in the conduct and strategy of inquiring itself."[6] Professor Bruner tells us that, "Grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully. To learn structure, in short, is to learn how things are related."[7]

In short, the *relational* role of the general education science instructor in an open society is to connect two things otherwise distant in the minds of his students.

SYNTHETIC: This is the instructor's task of creating curricula. This task is a particularly poignant one. The scientist who would say "All molecular biology is my domain" would be thought a fool (unless he happened to be James Watson) because the exponential growth of knowledge and journals and even abstracting journals has so far fragmented science as to place even a relatively small, definable slice of it beyond the reach of any single human mind. The instructor in general education science has the insurmountably greater problem of asserting that all science is within his purview. By necessity, if not by choice, the general education science instructor must be a person who creates for himself or herself a broad philosophical perspective to explain what science itself, as a totality, is all about.

I shall describe one such approach to this process of creating an intellectual rubric for the whole of science as I turn to the last problem of general education science curriculum development in the open society. Let me just summarize the role of the instructor by again saying that it is tripartite: he must evaluate his student-mix, attempt to show the relationships between ideas separated both in subject and in time, and create a philosophical rationale for the general education science enterprise. It takes, to paraphrase Gilbert Highet's critique of lesson plans,[8] a very strong-minded and far-sighted teacher who can see each day's work, be it a study of the decline and fall of the phlogiston theory or an introduction to Mendelian postulates, as part of a program extending over a year or more, a program whose function it is to introduce science, not as received doctrine or fact, but, in Daniel Bell's words, "with an awareness of its contingency and of the conceptual frame that guides its organization."[9]

WHAT ARE SOME ORGANIZING THEMES FOR GENERAL EDUCATION SCIENCE IN AN OPEN SOCIETY?

If we take as givens that, in an open society, the student body is extremely heterogeneous and general education science instructors see their roles as both complex and changing with time, it therefore follows that curriculum-development cannot be monophyletic. That is, curricula cannot be traced back to a common set of assumptions from which courses and units logically flow. Just as some botanists now believe that different groups of algae may have arisen independently rather than from a common ancestor, so too I think we can examine a number of different candidates for the central task of organizing theme in curriculum development.

THEMES: Epistemology, Methodology, History, Philosophy, Sociology, Technology, Esthetics, Ethics, Etc.

We might be tempted to follow Professor Kuhn's lead and call these themes "paradigms"[10] but for the fact that paradigms cannot exist side by side; you accept one only at the cost of rejecting another. The themes I am describing here, however, can and should be drawn on with variable weighting in creating general education science courses for an open society. Each of these themes will be of greater or lesser interest to citizens of this open society depending upon what interests, in Dewey's sense, they bring into the course.

How shall we use these themes to create curricula, and how will we be able to tell whether the resulting courses are general education science and appropriate to the demands of an open society or merely old disciplinary efforts in new clothes?

In order to answer these questions, I want to propose to you a model for general education science. In this model, I try to elaborate three orthogonal concerns: subjects, themes, and alternatives.[11]

SUBJECTS: On this axis, we find astronomy, molecular biology, computer science, geomorphology, paleontology, and all of the other disciplines that enliven the pages of indexing journals.

THEMES: Here we find the organizing principles which I listed above, *each of which cuts across all subjects.* For example, the concept of mechanism, one of the major metaphysical assumptions of modern science, can be demonstrated in any scientific discipline you might care to name.

ALTERNATIVES: By this term I mean to imply that, for every live scientific question, for every theory that proposes to explain the world, for every attempt to impose order on the whirring, buzzing confusion of existence, there exists what one of my colleagues calls "the Rashomon effect," the infinity of different interpretations by different observers.

Now this three dimensional model of general education science has one critical operational parameter which sets it apart from disciplinary science; you violate this rule only at the cost of leaving general education science entirely: *you must move through all three dimensions of this model, not just one or two.*

If, for example, you confine yourself to the subject of chemistry, what you are doing is teaching the epistemology, methodology, and so on of chemistry. You may produce very skillful chemists in the process, but your students will never attain the depth of interest (in Dewey's sense) that would permit them to see that organic chemists and trial lawyers share a common obsession for understanding truth in detail as the consequence of a long chain of syllogistic reasoning.

If, to commit another fatal error, you confine yourself to considering only the epistemology of science, your students will be able to recognize formal postulational-deductive systems in the formal propositional sense without yet grasping that, *in the real world,* such systems are constructed *ex post facto* by those who sweep up after what Professor Kuhn calls "normal" or "paradigmatic" science.

Finally, if you confine yourself to the axis I have labelled "alternatives," your students will be ignoramuses given to statements such as "Science doesn't know everything" and "Everything is relative" without understanding that the corporate body of normal science, the "community of practitioners," in Professor Kuhn's words, effectively defines what does or does not constitute orthodox inquiry under the current paradigms.

To reiterate come into my three dimensional model of general education science; stay as long as you are able; leave whenever you have to by whatever exit you choose. But this you must do: move through the three dimensions of subjects, themes, and alternatives while you are here if you wish to know the labyrinth we call general education science.

With this three dimensional idea of general education science for the open society in mind, let us now return briefly to examine some of the possible organizing themes to see how they might be used singly and in concert in our courses.

Epistemology: What does it mean to believe that a statement is *true* in the scientific sense? What assertions constitute valid statements about the real world? How can one *know* anything? These questions fall under the purview of the structural/analytic approach to understanding science, the method of Bell and Bruner which I have described previously. Many think that this may be the most *efficient* method for teaching science; is it also the most *effective*?[12]

Methodology: How does a scientist work? How does he create in syllogistic fashion a string of if-then statements culminating in a prediction about the movement of a meter or a cell? "From a drop of water," Sherlock Holmes says, "a logician could infer the possibility of an Atlantic or a Niagara without having seen or heard the one or the other."[13] A course which was literally nuts and bolts, or toasters and television sets, could, in my view, be very good general education science indeed if it lead its students into the larger concerns of my model.

History: I can only refer you to the *Harvard Case Histories in Experimental Science*[14] and to such works as Arthur Koestler's *The Sleepwalkers*[15] to open the way to asking how the scientist is affected by (and in turn affects) the prevailing world-view. Professor Kuhn's analysis of the rise and fall of paradigms will enthrall those students who are capable of making the initial leap of faith in accepting that other people see the world in other ways which are equally sincerely held.

Philosophy: This theme would lead us to examine our very modes of thought. The premise of the excluded middle, for example, leads us to make statements which are dichotomous rather than on a continuum, which are *product* rather than *process* assertions. Even today, Aristotle is alive and well in my students, for they find the complementarity of the wave and particle pictures of the electron or of light to be literally unthinkable.

Sociology: What is the "community of practitioners" to which Professor Kuhn refers? What is the structure of the scientific community? How is information disseminated through the scientific infrastructure? How do leaders emerge? How do revolutions occur? To students of a post-industrial society, ". . . in which the 'new men' will be the research scientists, mathematicians, economists, et. al.,"[16] this theme would indeed meet a basic interest in Dewey's sense.

Technology: Technology frequently is regarded as the stepchild of "pure science" when it comes to pedagogy. Yet our students encounter technological aspects of the scientific enterprise daily and the

"pure research" aspects only in occasional *Time* or *New York Times* articles. An examination of technology across disciplines and from many perspectives could indeed be a vehicle for demonstrating interrelationships between many diverse ideas.

Esthetics: "If it is beautiful, it must be true" could have been said by Pythagoras or Watson and Crick. The principle of Parsimony, Occam hard at work with his razor, is one of the metaphysical foundations of modern science. To show the role of esthetics in the acceptance of a new paradigm[17] and to explore why *some* experiments are widely regarded as "elegant" would indeed be a pleasing organizing theme.

Ethics: How much science does one need to know in order to make an adequately informed ethical decision? This sort of question frequently scandalizes orthodox scientists for whom a lifetime is not long enough to answer the question. Yet, increasingly, we find lay people in the roles of decision-making with respect to scarce life-saving medical resources. To show students how one goes about eliciting the critical information to *choose* in complex and uncertain situations might indeed be a powerful theme for general education science in an open society.

In summary, I have attempted to delineate the three critical parameters which must be considered in examining the role of general education science in an open society . . . students, instructors, holistic curricula. There is, however, one final element of particular importance to teaching in an open society: style. This is ephemeral and nearly impossible to quantify, and yet it is of crucial importance in creating *effective* courses. In my own case, stylistic considerations lead me to throw out the major concern of any course in the form of a challenge. In one, I leap headlong from the lecture desk in order to "prove" that the earth is at rest, else why am I not dashed against the wall. In another, I argue that my function, as a mechanism, is to reprogram *their* mechanisms. These examples I bring to you to suggest that advocacy, which we have always regarded as an inadmissible part of pedagogy, may indeed be a useful technique for leading our students into perhaps the most serious and challenging game that man has known: to know himself, his world, and how the two fit together. In an open society, general education must aspire to do no less.

FOOTNOTES

1. Task Force on Lifelong Education, *The Lifelong University,* Michigan State University, 1973.
2. Karl R. Popper, *The Open Society and Its Enemies,* 5th ed., Princeton University Press, 1966, p. 173.
3. Terry Armstrong, "Coordinating Science Teaching Methods With Levels

of Student Awareness," *J. College Science Teaching* 3(3), 187 (Feb. 1974).

4. John Dewey, *Democracy and Education,* Macmillan, New York, 1964, p. 126.
5. Daniel Bell, *The Reforming of General Education: The Columbia College Experience in Its National Setting,* Doubleday Anchor, Garden City, New York, 1968, p. 167.
6. Bell, *ibid.,* p. 160.
7. Jerome S. Bruner, *The Process of Educatnon,* Vintage Books, New York, 1960, p. 7.
8. Gilbert Highet, *The Art of Teaching,* Vintage Books, New York, 1950, p. 66.
9. Bell, *loc. cit.,* p. 8.
10. Thomas S. Kuhn, "The Structure of Scientific Revolutions, 2nd ed." in Otto Neurath, Rudolf Carnap, and Charles Morris (eds.) *Foundations of the Unity of Science,* V.2, University of Chicago Press, 1970, p. 58.
11. Gerald Holton, "The Thematic Imagination in Science," in Gerald Holton (ed.) *Science and Culture: A Study of Cohesive and Disjunctive Forces,* Beacon Press, Boston, 1967. Professor Holton argues forcefully (cf. p. 98) for a three dimensional model for understanding science. His model, which is not congruent with mine, has as axes the empirical or phenomenic, the heuristic-analytic, and "the dimension of fundamental presuppositions, notions, terms, methodological judgments and decisions—in short, themata or themes. . . ."
12. Professor Ivor K. Davies of Indiana University spoke at Michigan State on February 15, 1974 as part of our continuing series *INNOVATIONS IN COLLEGE INSTRUCTION.* He made the important distinction between *efficient* teaching ("Doing things right") and *effective* teaching ("Doing the right things"). In the former category, he places such things as stating clearly the formal structure of the course, while in the latter he includes a kind of psychological contract which students make with the instructor and with each other. This contract, in his view and mine, is constantly renegotiated throughout a course. His analysis is particularly valuable in considering education in an open society.
13. Sir Arthur Conan Doyle, "A Study in Scarlet," in Adrian Conan Doyle (ed.) *A Treasury of Sherlock Holmes,* Hanover House, Garden City, New York, 1955, p. 13.
14. James Bryant Conant (gen. ed.), *Harvard Case Histories in Experimental Science,* Harvard University Press, Cambridge, Massachusetts, 1966.
15. Arthur Koestler, *The Sleepwalkers: A History of Man's Changing Vision of the Universe,* The Universal Library, Grosset and Dunlap, New York, 1963.
16. Bell, *loc. cit.,* p. 87.
17. Kuhn, *loc. cit.,* p. 217.