

SCIENTIFIC EDUCATION:

An Analysis of the Views of Oppenheimer and Snow

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The phrase "scientific education" is to be used in one context in this paper: the education of non-scientists in science. Both C.P. Snow and Robert Oppenheimer have definite views on this area of education. The object of the paper is to compare, contrast, and analyze their views with the views of others and my own.

It is generally accepted that there is some difference between the scientific and the non-scientific disciplines. The many writings noting the existence of "two cultures," and a deficiency in communication between the two, are also commonly accepted. Some may take argument with my statement, particularly Leavis ¹ and Yudkin ², but they basically agree. Their arguments center around the definition and examples of culture. Yudkin claims that a third culture is emerging which will essentially assimilate the literary one into a modified scientific culture. Leavis simply argues for the sake of argument, producing biting, caustic comments and criticisms which often lower Dr. Leavis to the depths of simple name-calling. Even if his analysis of C.P. Snow can be considered "brilliant," ³ it is in poor taste, childish, and a hindrance rather than a contribution to the solution of the two-culture problem.

I chose to discuss the topic of Scientific Education because it is one of the more critical and neglected areas of the two-culture discussion -- and one of the most misrepresented. There is constant talk about the necessity

for scientists to become educated in the humanities and arts ⁴, and I enthusiastically concur. But the argument for the scientific education of non-scientists is a much neglected one (possibly because it is much more difficult to achieve).

C.P. Snow impresses me as an honest, sincere, and dedicated man who is intensely interested in the communication gap between scientists and non-scientists. His feelings are made particularly clear in his essay "The Two Cultures: A Second Look," ⁵ where he critically analyzes his earlier essay.⁶

Mr. Yudkin,⁷ discussing the "bridging" of Sir Charles' culture gap, claims:

The scientists could certainly bridge Sir Charles' gulf.

But it can only be a one-way bridge. For the non-scientist, an understanding of science rests not on the acquisition of scientific knowledge, but on scientific habits of thought and method.

Yudkin continues, on a later page:⁸

The most that might be expected would be that the education of children -- whether they subsequently become scientists or not -- should include an awareness of the most valuable achievements in our literary and artistic culture. For the reasons that I have outlined, the converse -- a useful scientific education of non-scientists -- is not a practical aim.

I submit that Mr. Yudkin has missed one of the more important points of C.P. Snow's lecture. I must admit that the bridge is much easier to cross in one direction than another, in the direction from science to the humanities. But it is certainly not impossible to cross in the other direction -- more difficult, perhaps, but not impossible.

What is Snow's idea on education? Tell it before you attack Yudkin or Snow.

Yudkin assumes that a scientific education for the non-scientist must be a "useful" one. I disagree. For one thing, he fails to qualify the term "useful." But assuming he means useful in the sense that the individual will find his scientific education valuable and of use to him in society, then Mr. Yudkin is in error. The non-scientist with a "scientific" education cannot by definition be a scientist in society. This does not mean that his scientific education is not useful. It is useful -- extremely useful -- in that he will have an appreciation for scientists, their work, and their amazing method. It will be useful in that the non-scientist will at least appreciate, even if he only partially understands, the significance of many scientific theories and concepts. The important point is that he will not harbor an antagonism or fear of science; he will appreciate it, hopefully, even if he does not fully understand it.

Snow, speaking of the two culture gulf, says:⁹

There is only one way out of all this: it is, of course, by rethinking our education. In this country, for the two reasons I have given [educational specialization and crystallization of social forms], that is more difficult than in any other. Nearly everyone will agree that our school education is too specialized. But nearly everyone feels that it is outside the will of man to alter it.

And later, on page 60:

The chief means open to us is education -- education mainly in primary and secondary schools, but also in colleges and universities. There is no excuse for letting another generation be as vastly ignorant, or as devoid of understanding and sympathy, as we are ourselves.

This helps at the beginning of your essay.

Snow is obviously not speaking only of scientific education. He is speaking against education which is narrow and specialized, both in science and in the humanities. One can be a narrow, specialized, and uneducated man as easily studying Renaissance art as studying quantum mechanics. But it is much easier, as Mr. Yudkin⁷ so clearly stated, for the quantum mechanist to study Renaissance art as a hobby than for the Renaissance art-ist to dabble in quantum mechanics.

Oppenheimer is but one of many examples of scientists who have successfully (and probably unintentionally) bridged the gap. This is expressed beautifully in Jungk:¹⁰

...the amazing "Oppie," who managed to pursue in Gottingen not only his physical studies but also his philosophical, philological and literary hobbies. He was particularly deep in Dante's Inferno....

The same Oppenheimer, when asked why he decided to teach at the University of California, answered:¹¹ "Just a few old books. I was enchanted by the collection of sixteenth- and seventeenth-century French poetry in the university library." This is obviously a scientist who is much more than a scientist; he is also a lay "literacist" and philosopher. Oppenheimer expresses his concern for those who also appreciate poetry and philosophy, but cannot appreciate science:¹²

There is no doubt that even the theory of relativity, which has been so much vulgarized and so little understood, that even the theory of relativity is a matter which would be of real interest to people at large. There is no doubt that the findings of biology and astronomy and chemistry are discoveries that would enrich our whole culture if they were understood.

are all
non-
scientists
of humanities
or literature
do this?

And what is perhaps more troublesome, there is a gulf between the life of the scientist and the life of a man who isn't actively a scientist, dangerously deep. The experience of science -- to stub your toe hard and then notice that it was really a rock on which you stubbed it -- this experience is something that it is hard to communicate by popularization, by education, or by talk. It is almost as hard to tell a man what it is like to find out something new about the world as it is to describe a mystical experience to a chap who has never had any hint of such an experience.

Is this the ultimate heresy -- a scientist talking of mystical experiences? But while I am on the subject, I will quote one more scientist, a brilliant, eccentric, and oft-misunderstood man -- Albert Einstein:¹³

The most beautiful and most profound emotion we can experience is the sensation of the mystical. It is the sower of all true science. He to whom this emotion is a stranger, who can no longer wonder and stand rapt in awe, is as good as dead. To know that what is impenetrable to us really exists, manifesting itself as the highest wisdom and the most radiant beauty which our dull faculties can comprehend only in their most primitive forms -- this knowledge, this feeling is at the center of true religiousness.

The consideration of non-specialized education in areas outside of one's particular specialty is an important one. Snow¹⁴ admits that the problem is particularly acute in Great Britain but is, in fact, being solved in the United States by the emergence of a third culture, the social scientists.¹⁵ If scientists and engineers have some amount of leisure time, they will often cross the gap and develop interests in non-scientific areas -- IF they are aware of the existence of these areas. The same is true for the non-scientist. He may find himself reading a copy

of Scientific American or one of the other responsible and not overly technical magazines -- IF he is not afraid of science. This leads us back to the topic of education.

It is quite possible to organize an educational program or system which will provide the functions of initial awareness and knowledge in many areas -- both in science and in the humanities and arts. Again I cite the oft-cited examples: the humanities and tutorials programs; there is a strong need for similar programs in the sciences.

If these programs are offered, will the students respond? They will -- and very enthusiastically.

One particularly competent Photography 1A instructor here at San Jose State College has taught his students the basics of quantum mechanics, the wave-particle duality, the essence of the structure of atoms and molecules, optics, and chemical reactions -- in addition to conventional photography. The response has been unanimous. The students are intensely interested. The enrollment in the course has tripled. These students had only a common high school mathematics and science background, and they will graduate with an excellent conceptual understanding and appreciation for basic physics and chemistry -- a feat which nearly all of their non-scientific classmates will fail to accomplish. And this is only one course. A series of courses, designed for a continuity of conceptual presentation with competent and enthusiastic professors, could instill an understanding and appreciation of science in literally thousands of students on this campus. The major problem is finding the men (or women) to teach the course.

Here you abandon your theme - comparing off-kilterness to science education as science. You've tacked on a good tail but to the wrong animal.

This semester the Engineering Division offered a course titled "Cybernation and Man," a commendable attempt at partially spanning the technology--sociology gulf. When the concept of entropy -- the second law of thermodynamics -- (which, incidentally, was an excellent example in C.P. Snow's lecture ¹⁶, though he handled it very poorly) was to be presented, one electrical engineering professor went to the blackboard, scrawled an equation, and said this is the second law of thermodynamics. In a class of nearly all non-science majors, most of whom hadn't seen an equation since high school, this was a ridiculous and frankly irresponsible approach to the concept. The result was to immediately alienate the students from a concept which is perhaps the most significant in all of science. The concept of entropy (the universe's continuous and universal tendency towards disorder and randomness) has a very significant philosophical and theological implications. This is one example of the problems involved in teaching science to non-scientists. It will be a simple task if the right instructors are found, e.g., the Photography 1A professor. The proper men, teaching science and using possibly the "case approach" suggested by Conant¹⁷, will contribute much toward eliminating the gulf -- in its most difficult direction.

In conclusion, I would like to quote from an article by President Clark:¹⁸

I am certain that we have never really tried to teach science and mathematics to non-scientists. I could almost assert that there has been a general conspiracy, conscious or unconscious, to keep him from learning science and mathematics. Our view of education is so instrumental that we consistently direct the student away from mathematics unless he is going to be a scientist or engineer. We rationalize our behavior in immediate vocational goals, or more subtly on the general ground that natural interests divide the future scientist from the future man of letters. I do not believe it.

Neither do I.

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