PLACE OF SCIENCE IN GENERAL EDUCATION

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The emergence of the United States as a leading world power and the obvious lack of preparation on the part of our citizens and leaders for their widened responsibilities has resulted in the realization of a need for a common grasp and a common over-view in the handling of facts and ideas in many discrete and isolated fields of knowledge. This great need has been met by educators through general education. The term has many and vigorous antagonists, especially in the science field, mainly because of a misconception and a misunderstanding of its fundamental meaning. Defined very simply, general education is non-vocational; it is that education which is the antithesis of a specialized education. However, general education is really a philosophy of education, and consequently has shades of meaning and application that are not so simply defined. In the East, the problem has been studied as "integrated" education, a term probably more readily acceptable to faculty members. There, general education is considered as only one phase of the broader integrated education because general education is concerned with giving all students, regardless of the later area of specialization, a basic understanding of the sciences, social sciences, and the humanities, culminating in integrated knowledge.

Whether we call it general or integrated education, the educators in the scientific world have been challenged: first, to devise suitable means of educating the layman, enabling him to have a better knowledge of science, a better understanding of its philosophy and methods, and a deeper appreciation of its potentialities and its limitations; second, to supplement the efforts of the social scientists and the teachers in the humanities in the attainment of the common goals of integrated understanding and appreciation. Whether or not this challenge be recognized or accepted depends on the open-mindedness and honesty of the scientists, and the rigorous, ruthless, and patient intellectual grasp of the many difficulties contingent on that challenge. During the past several years many scientists have expressed their opinions on this educational problem. Dr. Anton Carlson of the University of Chicago stated:

> If it be true that an understanding of the scientific method and the fundamentals of the nature of man and the nature of the universe already achieved by the natural sciences is significant in a liberal college education, it would seem timely that we of the college faculties study this problem again, for I am satisfied that our nondescript "science requirement" for graduation usually falls short of the above goal. Streamlining the natural sciences in the college in the direction of purely vocational and professional training will not bring that goal even within sight of the mine run

of college students. . . . We of the faculties must re-evaluate and reconstruct our entire college curriculum in the directions of essentials and mastery, and not primarily in the direction of speed, technical trades and professions, no matter how strong the myopic drive in the latter direction may grow. If we could discover the essential core of liberal education, then mastery, rather than speed would seem to be the goal.[1]

Along the same line, Dr. James R. Kilian, Jr., the President of Massachusetts Institute of Technology, recently stated the need for a broader general education for science students:

Engineers, scientists, physicians and other professional men are often called upon to assume important positions of leadership in the community. Unless they are aware of the major issues of the world, they may find it difficult to give competent direction. . . . Colleges have a profound responsibility to develop men and women who are not only skilled technicians but alert, intelligent citizens.[2]

Dr. Kilian explained that the objective of MIT is to educate top-flight engineers, scientists, and architects who may become community leaders. When technical education is too narrow, it tends to restrict the development of leaders. He insists that professional schools everywhere place greater emphasis on the teaching of humanities. Twenty percent of the total curriculum of the scientist at MIT runs to humanities, and he belives that in the years to come there will be a substantial increase.

There has always appeared to be a dichotomous viewpoint on science. Some scientists have exaggerated the need and importance of their subject matter to such an extent that their schools are turning out brilliant physicists and chemists with little background in cultural education or a vital preparation for living in a world of immediate social and economic problems. They use the scientific method in their field unfailingly and blindly but seem to be incapable of making the transfer of training to their problems of life. As Professor Phillip Frank of Harvard stated in the *American Journal of Physics,*

The result of conventional science teaching has not been a critically minded type of scientist but just the opposite. . . . This failure prevents the science graduate from playing in our cultural and public life the great part that is assigned to him by the ever mounting technical importance of science to human society.[3]

To such scientists, science is the *end-all* of education.

The other viewpoint on science teaching is that taken by many professors of the social sciences and the humanities, and by many scientific workers themselves. They look on science as a mere tool, a useful servant of humanity and forget that it is an integral part of human knowledge. They confound science with technology. Science aims at a systematic understanding of the world, while technology aims at the construction of consumers' goods on the basis of such theoretical understanding.

Fundamentally, the problem seems to be to influence all members of the faculty to appreciate the importance of each discipline and to so integrate the subject matter that the foundation of each liberal arts student be soundly based on all the broad areas of learning. The common criticism, as exemplified in the

[1] Carlson, Anton J., "The Offerings and Facilities in the Natural Sciences in the Liberal Arts Colleges," *North Central Association Quarterly,* XVIII, No. 2. (October, 1943), 154.

[2] Education in Review, *New York Times,* March 27, 1949.

[3] Frank, Phillip, *American Journal of Physics,* XV (1947), 202.

statements of the men quoted above, has often been that the scientist has over-loaded his curriculum to a much greater and more obvious extent than the social scientist and the student in humanities. However, just as educators will insist (and rightly) that a scientist is not liberally educated unless he has a good background in history and socio-economic problems, so, too, no one who is ignorant of science in nearly all of its aspects can be considered an educated person.

Dr. Van Evera of George Washington University recently discussed the position of chemistry in our present-day liberal arts education. He admits that the so-called liberal arts college no longer gives a liberal arts degree but rather a series of junior professional degrees and thus we do not truly have liberal education in the original sense of a hundred years ago, which was that education turned out men who used beautiful English naturally, who had a great breadth of knowledge, and who were quite practical in their approach to the problems of life. However, Dr. Van Evera states that the chemistry major's curriculum of today with its requirements in history, sociology, economics, and English, is nearly as broad and fundamental as was that of the liberal arts student a hundred years ago. And thus he claims that the science major is a far more broadly trained man than is his classmate who has almost no science. This statement depends, of course, on the requirements of each chemistry department for work in other fields versus the requirements in science for the non-science majors.[4]

Consequently, as a result of these divergent viewpoints on the present status of science in the liberal arts college, the two-pronged challenge thrown to the scientists must be accepted and studied. It is a problem that deserves immediate action, not one to be cast aside as the mere bickering of educationists.

The first challenge was to plan courses for an integrated general education program that will enable the non-science major to obtain a better knowledge of science, a better understanding of its philosophy and methods, and a deeper appreciation of its potentialities and its limitations. Does the system of elementary single-science courses given alike for majors and non-majors meet this demand? This question can be answered only in the light of the objectives of the course related to the general education of the student. Much discussion in regional work-shops and in national conferences has centered around this question, with the consequent development of basic general courses, scholarly in character but selective in content, involving the integration of several sciences and based on the purpose of acquisition of certain broad aims.

There is still a great deal of confusion surrounding the question of the proper content of a general course in science. A survey of what has been done along these lines has been edited by McGrath in *Science in General Education*.[5] Twenty-one representative colleges and universities have cooperated in the study and much valuable information is here available. No matter how many

[4] Van Evera, Benjamin D., "Chemistry and Liberal Education," *Chemical and Engineering News*, XXVI, No. 7 (February 16, 1948), 446.

[5] McGrath, Earl J., Editor, *Science in General Education*, Wm. C. Brown Co., Dubuque, Iowa, 1948.

and how varied the plans are that are studied the one criterion which is used in building a general course is: How much does the teacher have to give? Each general course is individual and unique in method of approach, selection of material, the organization of the material and emphasis. The only underlying common denominator is the end and objective of the general course, which is concisely stated in the fourth objective quoted by the President's Commission on Higher Education: To understand the common phenomena in one's physical environment, to apply habits of scientific thought to both personal and civic problems, and to appreciate the implications of scientific discoveries for human welfare.

Besides elementary science general courses, other science courses should be devised to be offered as electives to non-science majors, upper classmen, so they can broaden their general background in science. These should not be laboratory courses, for a non-science major will not elect a subject that will take a considerable amount of time. He is interested in fundamental knowledge, not in techniques. We science teachers often offer the observation that our majors must be generally educated since they frequently elect subjects outside their field in their junior and senior years, and that the non-science majors seldom, if ever, elect anything in science to balance their general education. Though this is true, the fault probably lies with us. We do not offer two and three hour courses in science with little or no prerequisites that any liberal arts student is invited to elect. Most of our science courses, if elementary, have long hours of laboratory work, and otherwise have heavy prerequisites.

Now to the second part of the challenge thrown to the scientists: along with the faculties in the other areas, they are to integrate subject matter into one whole, so that the student realizes his common goal of understanding and appreciation. This is a plea to cut across departmental lines in order to unify learning, to build not only vertically through the subject matter structure of the course but to spread horizontally, reaching out for implications in other and allied fields, linking together science with social science, with the humanities, with language, and with communications. General education courses are intended to impart a broad point of view, looking at the subject matter in its relation to the whole range of man's practical and intellectual interests and as part of the essential background against which the problems of contemporary civilization must find their solution. The suggestion has been offered that the general education of the science major be broadened by means of a course given in the senior year which would integrate related sciences and also show their relationship to non-science fields. Such a course, it is obvious, requires a generally educated teacher, and it is thus inevitable that the course reflect the mind and personality of the teacher far more than the traditional purely departmental courses. The success of any of these general courses, the rigorousness with which they are handled, and the strict regard given to the prin-

ciples of exact, systematic inquiry, depend primarily and solely on the teacher. There is no reason, except in the individual teacher, why any general course should be accused of dragging down academic standards by being a "watered-down" course.

The many difficulties and advantages of such courses need to be analyzed by individual institutions in the light of the needs of their students, the qualities of their faculties, and the purposes or objectives of their curricula. Only in this way will the challenge which the modern world has thrown to education be met.