

THE PLACE OF NATURAL SCIENCES IN THE LIBERAL ARTS CURRICULUM*

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The volume of the remedies and panaceas offered for the treatment of higher education is, itself, a symptom of functional maladjustment. There seems to be no end to the publication of criticisms of our colleges and universities. Each writer points out that our educational institutions are failing in this or that, depending upon whatever phobia happens to be his hobby. Attempts, from time to time, to meet these criticisms by making changes in our curricula and educational practices have resulted in a hodgepodge of purposes in higher education. Difficulties always arise when objectives are confused.

In this confusion we have failed almost entirely to distinguish between training and education. These have come to be regarded as one and the same thing, when, in reality, they are entirely different. By training we mean learning to do some one thing or a set of things well. One may train himself avocationally, for instance, by repeatedly hitting a golf ball until he can do it without producing a hook or a slice, or by performing the various motions in baseball until he is sufficiently skilled to be valuable to a team. There are those who are using our colleges for avocational training. But since the decline of the apprentice system, the universities have been called upon to comply with a demand to provide training of a more serious nature: training necessary to build a house, play the piano, teach a school, fill a pharmacological prescription, win a lawsuit, or to practice medicine. For these things training is necessary, but a person trained to be skillful in any of them might not be educated.

This necessitates a brief discussion of the nature of education. I take education to be a preparation to help us live as far above the animal plane as our inherited potentialities will permit. It is the organization of knowledge into human excellence and the ability to increase in wisdom through the power to reflect on the knowledge possessed. It should enable us to understand something of the nature of the world and man and to help us in appreciating that which is beautiful about both. It is the art of making living itself an art. It offers training in one thing only—that of thinking. The processes of education should look upon the student as a man and not as a future wage-earner. They should help him attain temperance of judgment. They should train him to be a better social creature and, therefore, of greater value to his fellow-man, because he has the foundation, the proficiency, and the desire to think clearly, fearlessly, and honestly about everything.

I do not agree with some contemporary writers that training has no place in our universities. They arrive at their conclusions by using the historical approach. The fact that professional training was not included in the scope of the early colleges is no reason for refusing to accept the responsibility that can well be made an asset both to the technical student and to the institution. But a discussion of training in our professional and technological schools is aside from my subject, for this paper deals with the liberal arts college which is also called the college of arts and sciences.

The primary purpose of the liberal arts college is to promulgate education in its more limited sense. Its field is divided. It must first supply the student with introductory subject matter, a task that more properly belongs to secondary education. Having helped him build a foundation from this material, it must next provide an opportunity for developing the

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ordinary processes of reasoning. After that the liberal arts college should lead the student to a more intimate and detailed knowledge of a single field and leave him equipped to go forward in that field. We might say then that the purpose of the liberal arts college is to give the student the factual foundation and the practice for thinking, believing that a student so equipped can handle the ordinary problems of life and succeed in all fields where intelligence can develop a technique, being excluded only in fields where technical training of a special sort is required.

A common error that the American universities have made is in believing that their products will not have ordinary intelligence and in assuming to do their thinking for them. They attempt this by looking forward to all possible future occasions for intelligent action and by training the student in handling these possible situations along lines thought out ahead of time by a presumably intelligent faculty. For instance some Oklahoma colleges are offering courses in "Theory of Coaching Tennis," "Care of Shop Equipment," "Problems of the High School Principal," and "Economic Problems of the Household," while some out-of-state colleges offer such choice predigested bits as "Book Reviewing," "Social Life of the Home," and "Principles of Home Laundering." In accordance with the common practice of Oklahoma liberal arts colleges, from sixteen to thirty hours of these courses may count toward a Bachelor of Arts degree.

Assuming that our liberal arts colleges will diagnose their own condition and return to their primary purpose, I shall attempt to point out some of the ways in which the teaching of courses in the natural sciences can contribute to the objectives of liberal arts education. I believe that the greatest general benefit to be derived from the study of the sciences is training in logical thinking. The student in any science learns to place cause and effect in their proper relationship and forms the habit of going from the one to the other in orderly fashion. The sciences teach the student good mental housekeeping. They are objective courses in applied logic, which has been called the summary of the processes by which the human mind, operating as an instrument of knowledge and medium of self-expression, shapes its course.

As introductory to some of the more specific curricular values of the sciences, may I suggest that the confusion of objectives previously alluded to has been responsible for a certain loss of orderliness in liberal arts education. This is clearly manifest in a common departure from the practice of enforcing prerequisites to courses that naturally require foundational knowledge from other fields. Few practices are as detrimental to sound scholarship as laxity in observing obvious prerequisites. Teachers will usually teach down to their students. If certain foundational material from other subject-matter is needed, the instructor will stop to supply it if an appreciable number in the class show lack of a minimal knowledge of the precedent field. This results in several faults. The instructor is hardly likely to cover the interrelated material adequately even for the needs of his course; it is quite possible that he will not be accurate in a field that is other than his own; he robs his course of class time; he disappoints those students who have built up to his own subject and want a real course in it. Worst of all, this practice reduces most of our curricular units to a common plane, making beginners' courses of them all.

Since a number of fields of collegiate study are built upon a foundation of physical or biological science, a proper observance of prerequisites would add to the responsibility of the various science departments. This is merely stating the reciprocal of my main thesis that a higher requirement in the natural sciences would raise the standards of liberal arts instruction. To develop this contention further, I shall attempt to show

the foundational relationship of the sciences to several other departments of liberal arts study.

Sociology is commonly designated as a social science, but has its roots in the natural sciences. In the great practice of living together, the scientific method meets its greatest challenge. Social systems, like Topsy, have "just grown up," a thing that is not unique, for so did the system of medicine, so did chemistry, and, for that matter, so did practically every other field of scientific endeavor. But just as the art of healing became a science by having been systematized and laid out along logical lines, so the subject of sociology must be similarly treated. A decade ago, Harry Elmer Barnes stated that the social sciences would make progress only to the extent that they might adopt the methods of the physical and biological sciences. I believe it is justifiable to say that in the ensuing time the progress of the social sciences has borne out his prediction. It is not easy to get used to the idea of regarding society itself as a proper object for scientific research. It is imperative that we get used not only to this novel idea, but also to its counterpart, the fact that science must be regarded as a social activity if it is to meet its obligations to mankind and do service for the state.

After all, human society is an animal association striving with an environment consisting mainly of its own members and inorganic factors. We might speak of sociology as human ecology. The same fundamental laws hold for a group of human animals as for any other association. Human society will be better understood if animal societies are studied. Then, too, the sociologist needs a knowledge of genetics, eugenics, biometry, hygiene, sanitation, endocrinology, parasitology, and even, at times, something of the chemistry of germicides and insecticides.

Our national experience of the last few years has emphasized that the people of this country, in fact of the world, must learn to think clearly along economic lines. It is quite likely and very desirable that added emphasis will be placed on the study of economic principles in the liberal arts curriculum. Let us, then, consider what the sciences have to offer as a foundation for the study of economics. The same type of reasoning is involved in the two fields. The student trained to think in the sciences will reason well on economic problems. Again he will go from cause to effect without muddling the process. The study of economics demands a more mature type of mind than is required for the pursuit of most subject matter. It is not a field for training minds for there can be no experimentation. The laboratory work is done largely in the field of practice, and there, wrong answers are costly.

But the sciences hold another important relation to modern economics. Since we are living in an age of science, economic advancement and economic welfare are bound very closely to scientific advancement. Admitting that scientific advancement has brought on our economic distress, it is necessary to state as a corollary that the cure lies in administering more of the same draught. The successful business administrator must know something of the sciences that are involved in his industry and it would be difficult to find an industry in which one or more sciences are not involved. Again and again we have found that a single scientific discovery has revolutionized an industry and all associated lines of business. Although the executive can employ his technical staff, he must, at least, be able to discern the importance of scientific trends. There is a certain amount of thinking that cannot be hired out.

The measures at present being taken to attain economic adjustment are themselves indicative of the relation of science to economics. Soil conservation, flood prevention, hydro-electric projects, reforestation, climate control, malaria eradication, and other disease prevention meas-

ures are a few of many current projects, all having a definite relation to the sciences.

The relation of the natural sciences to the mental sciences is obvious. Since the brain is an organ of the body, the study of its function is as much a part of general human physiology as is the study of the kidney, liver, or spleen. Although I grant that this particular phase of human biology has grown to a stage where it is justified in assuming autonomy, the very nature of its subject matter demands a groundwork in the foundational sciences.

Too many of our colleges, especially those in which a demand for courses counting toward teachers' certificates is made within the school of liberal arts, allow lower classmen to flock into psychology courses. Considering that the laws of physics manifest themselves throughout most if not all of psychology, and that it is quite impossible to understand much about protoplasm, nerve action, and nerve nutrition without a knowledge of the fundamentals of chemistry, it is quite evident that these physical sciences are a proper prerequisite to psychology. Other phases of the subject require a knowledge of the animal kingdom and of the comparative complexity of their nervous systems, something of anthropology, evolution, heredity, and obviously a knowledge of the interrelations of the nervous system and the other systems of the animal body. But the most important contribution which the various departments of natural science can make to the department of mental science is in providing it with students trained to think logically and acquainted with the scientific method of approach. Of course, it might be argued that students can receive this training in the latter department and there is no wish to deny this any more than there is a desire to exclude psychology from the family of biological sciences. My contention is that since psychology requires foundational courses in certain other sciences, it has the advantage of starting with students better trained in objective thinking. Such students can be led into a highly specialized field to do a mature type of work.

In regard to the application of the scientific method to mental science, Paul W. Ward has said, "The civilization of an age is no better than its method of thinking; indeed, its civilization is its scientific procedure in application. A generalized account of the scientific method of a cultural epoch is both a statement and a criticism of its civilization."

We might approach the relation of the teaching of the sciences to the study of philosophy by referring briefly to the history of the latter subject for it would seem that here also ontogeny might be said to repeat phylogeny. Before the time of Socrates, there had been considerable speculation about natural phenomenon and cosmic laws. Philosophers were already beginning to seek other than mythological explanations for their observations in the world of objects. Although their scientific interest was genuine, these early Greeks lacked the logic of a scientific mind. Socrates took the first step in the scientific life-history of a race by introducing critical intelligence. The second step was taken by Plato who applied his principles of reason to abstract thought. But it remained for Aristotle to apply the same principles to concrete things and thereby give science its real beginning.

Does it not seem likely that somewhat the same process would be effective in producing philosophers as was effective in developing philosophy? Should they not be led through the same stages of scientific development? We look to philosophy to correlate the various other fields of learning. Philosophy has been called the Queen of the sciences because it is the culmination of them all. How then, can philosophy be taught to students who, at best, have had courses in only one or two fields of natural science?

Dewey says that without initiation into the scientific spirit, one is not in possession of the best tools which humanity has so far devised for effective directed reflection. In it may be realized that desire for exact knowledge. It tests all things in the light of experiment and by appeal to cold objective fact. It might be said that science is reason in contrast with credulity.

The field of ethics lies within that of philosophy and that of religion is adjacent. Of course, the teacher of ethics does not attempt to train his students in a better system of conduct. If he were to, I should think the result would be much the same that accompanied efforts that have been made to give courses in "Character" in the public school; these attempts were abortive partly because the pupils cheated in examinations. The attainment of better ethical standards and character building have to be the incidental results of other educational experiences.

Touching this point, Charles L. Reese in his presidential address before the American Chemical Society, said, "The object of all scientific work is the search for truth, requiring honesty of purpose, the enlargement of human knowledge and service for the benefit of mankind. These ideals, when properly instilled into the student, by the teacher, usually have the effect of stimulating honesty of character, which, I am glad to say, is characteristic of all scientists in general."

Our colleges and universities, both state and privately endowed are re-thinking the teaching of religion. Sectarian colleges have abandoned the teaching of narrow, denominational doctrines, offering instead instruction in the principles of religion. The religious conceptions of scientists are seldom narrow because their science gives them perspective. Again I should like to quote Doctor Reese. "Progress cannot continue, in this material world of ours, any more than that spiritual progress can be attained, without the eternal search for truth, constant endeavor to open the vistas of nature, through, not the work of the individual, but rather by the coordinated work and thought of many.

"Love of the beautiful, in nature and art, the love of music, of thought expressed in art and architecture, or in literature and poetry, are the evidences of God in man, and so I feel that the man or woman who devotes his life to the search for truth in nature has the spirit of God in him. It is only by such spirit that we can possibly approach the laws of nature, which has brought order out of chaos in the universe, has made man and given him the power to think."

If I have made a case for the value of the sciences as educational foundation-laying material—a task that is not difficult before the judicial authority of this Academy—may I now point out that Oklahoma colleges are woefully negligent in recognizing this value in their required curricula. The average minimum number of hours of the physical and biological sciences required for graduation from the ten liberal arts or arts science colleges in the state is 5.7, and our six teachers' colleges will grant an A. B. or B. S. degree with as few as four hours in laboratory science. A bachelor of arts degree may be obtained from two of our colleges without any physical or biological science whatsoever. Only one college requires as much as fourteen hours, and only two others have the next higher requirement of eight hours. Strange to say, one college will grant a bachelor of science degree to a student who might have taken no science at all.

Of course, this phase of curricular requirement is strengthened a little by having a group requirement with mathematics. But since substitutions can usually be made for the primary mathematics requirement, the total math-science requirement remains low. Furthermore, the exaction of laboratory work tends to reduce the number of students who do elective work in the sciences. In fact, considering that we are undoubtedly living in

an era that can well be designated as an age of science, our colleges are turning out students whose courses, in general, whether by requirement or election, are not representative of, nor preparatory for, the civilization for which they seek preparation. In fact, the average student does not get enough foundation in the sciences even to protect him against pseudo-science. This is a real danger in an age that knows the force of organized promotion.

I should like to close my discussion by paying tribute to the man who first called attention to the value of the natural sciences in education. I refer to Thomas H. Huxley and shall use a quotation from one of his essays as my summary.

"That man, I think, has had a liberal education who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength, and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of Nature and of the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of Nature or of art, to hate all vileness, and to respect others as himself.

"Such an one and no other, I conceive, has had a liberal education; for he is, as completely as a man can be, in harmony with Nature. He will make the best of her, and she of him. They will get on together rarely; she as his benificent mother; he as her mouthpiece, her conscious self, her minister and interpreter.

