

PAPER FROM THE GENERAL PROGRAM

INDIRECT CONTRIBUTIONS TO THE PROMOTION
OF SCIENCE

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There have been many explanations offered to account for the distressing situation in which the world has found itself these past five or six years. From some quarters have come intimations, in fact, assertions, that all our troubles are to be attributed to the development and the applications of modern science.

From others have come more tolerant, less dogmatic statements, modest suggestions we might call them, that science has outrun its teammates, philosophy and religion, and as a consequence man has come into the possession of forces which he is unable to control, and which are destined to destroy both him and the world in which he lives. It is strongly hinted that there should be declared a moratorium on scientific research until developments in the fields of the humanistic studies should make it safe for man to be intrusted with more knowledge of the physical world.

However, since there has not yet developed a Mussolini, a Stalin, or a Hitler with such dictatorial powers as to be able to prohibit scientific progress, and since there are still quite a few individuals who feel that it is not too much knowledge but too much selfishness, not too much science but too little religion, genuine religion, that is at the foundation of our trouble, and since men of science not only have no desire whatever to hinder the progress of the social order, but on the other hand would gladly cooperate in any endeavor to speed this progress, the march of science goes steadily on and always to the ultimate enrichment and not to the impoverishment of the human race.

Testimony in support of this statement is found in the great interest taken by the country in the Century of Progress Exposition, in the enthusiasm manifested at the recent great meetings of men of science both in this country and across the sea, in the wide publicity given the reports and addresses at these scientific congresses by the great metropolitan papers here and abroad, and in our own state in particular by the large number of papers in the various branches of science appearing in the program of this meeting of our Academy.

The spirit of science will not die; it cannot be strangled; it is immortal; it is as eternal as the Creator whose handiwork this scientific spirit is ever seeking to know, to understand, to interpret to all mankind.

Now science grows both by direct and indirect contributions. He who goes forth with an inquiring mind, bent on the search for truth, who

carries on experiments with his own hands, records accurately observations made with his own eyes, discovers and establishes facts hitherto unknown—he is a direct contributor to the progress of science. He who plans or suggests researches for others, as do our professors in graduate schools and our directors of research laboratories, who assembles data, detects new relationships, envisions the intrinsic meanings in the phenomena of matter, of energy, of life, whose imagination directs him to hitherto unopened doors which he himself or others at his suggestion may open—he also is a direct contributor to the progress of science.

But established scientific knowledge has become so broad and so deep, its horizon has become so extended that any serious contribution to its further enlargement can be made only at considerable financial cost. Laboratories, libraries, implements and tools of intricate mechanism and expensive construction are absolutely essential for the successful prosecution of any significant scientific research.

Any man, therefore, who builds and equips a laboratory, establishes a library, endows a research foundation, provides research fellowships, or helps to increase the funds available for scientific investigations is an indirect contributor, but no less a contributor to the progress of science, a benefactor of mankind. We have had in this country not a few conspicuous men and women of this class, and a far larger number more modest in their gifts, unheralded and unsung, perhaps not even known to the public, who, nevertheless, are indirect contributors to the progress of science and worthy of our appreciation and remembrance.

But in this brief paper I have in mind indirect contributions of another kind. Most of us here are teachers, college teachers, high school teachers, some of us members of faculties in institutions labeled universities, but engaged for the most part in undergraduate work. Each of us would enjoy the thrill that comes from the public announcement of an important discovery by "Mr. So-and-So" (ourselves). We should find much satisfaction in seeing our name attached to some epoch making paper appearing in such and such a scientific journal, which accepts only papers of unusual merit. But few of us have the technical skill to surpass all others in the prosecution of some research requiring exceptional technique, few of us are gifted with the imagination to conceive of methods superior to those designed by all others working in the field. Furthermore, most of us are so loaded with routine teaching schedules, or with other duties equally as time-consuming, that we have little time left to carry on the long series of experiments, the many confirmatory repetitions, or the long hours for searching books and journals to establish priority, all of which is so essential as prerequisites for the preparation of any creditable scientific paper.

Is there nothing we can do to make at least an indirect contribution to the promotion of science? Some of us feel that there is much we can do. Promote the development of a potential scientist and we contribute to the development of science itself. What is it to be a teacher of science? Surely it is far more than being a purveyor of scientific knowledge. Undoubtedly there is a certain amount of satisfaction to be found in supplying this particular kind of pabulum to youthful minds. But

does what we give them really feed them, nourish them, add to their growth? Does it not too frequently give them mental indigestion? Do we not too often have the wrong idea about teaching? Is not real teaching a process of creating hunger rather than satisfying it, creating a thirst rather than quenching it? Or, using another figure, is it not the function of the true teacher to discover intellectual sparks and fan them into flame; or, again, to arrest for a moment purposeless youth and give it purposeful endeavor with the dynamic of a great inspiration?

Applying these ideas to the teaching of science, is it not the duty of every teacher of science to endeavor to detect every potential scientist within his keeping, and is it not his sacred privilege to assist to his utmost in bringing that embryo to maturity? And who is a scientist? Who but he who is making direct contributions to the advancement of science, making some contribution to its clearer interpretation, its more significant implications? Is not, therefore, he who contributes to the development of a true scientist at least an indirect contributor to the promotion of science itself? Need we feel, therefore, that we must apologize for being teachers, if we are teachers in the highest meaning of that word? Better an effective teacher than an ineffective scientist.

It is a great privilege to be a teacher who can discover latent creative scientific ability in others and give it encouragement, inspiration, and direction until it attains fruition, reaching that stage in which it is recognized as a creator of science, a contributor to human knowledge in the interpretation of science, a man of successful scientific research. Our Academy should and does foster the teaching of science in this high and holy sense, and many of the papers presented at these annual meetings are expressions of this effort to cultivate the scientific spirit in the hearts of students with whom we are associated in classroom and laboratory. In many cases, far more important than the papers we read here are the impressions that have been made upon and the stimuli that have been given to the students in our laboratories who have had some part in the preparation of the data upon which the papers are based. In many cases, of much more significance than our direct contributions to science are the indirect contributions we make as teachers in the discovery and nourishment of the vital embryos which will become the scientists of tomorrow.

I know a college teacher who lectures to beginning students in general chemistry and who spends many hours a week in the laboratory looking for embryonic chemists. When he finds one, he gives him considerable time and personal attention for the next three years. In consequence, this laboratory is represented by many able chemists and teachers of chemistry throughout the country. I know a teacher of physics whose upper classes are comparatively small, but who had the pleasure last June of having five of his former students take their doctor's degree in physics in five different universities extending across the country from Yale to Minnesota. I know a teacher of zoology who, at the close of each year, migrates to Woods Hole for the summer with four or five of his most promising junior students, who, largely at their own expense, spend the summer vacation in acquiring a taste for

zoological research. It is his way of placing the stamp of discovery on embryonic zoologists. In my vicinity there is a professor of botany who, with his associates, spends many hours a week in giving their students an insight into botanical research, and with gratifying results. Eight years ago there applied for admission at a certain university in my neighborhood a youth who stood at the bottom of a class of 365 high school graduates. The Committee on Admission hesitated to take him. What could there be in such a freshman worthy of consideration? However, he was given a trial, and he fell into the hands of the head of the geology department, who found in him an embryonic geologist. As a result, this young man took his doctor's degree last June in geology at Johns Hopkins University with both Phi Beta Kappa and Sigma Xi honors.

I feel that such statements as these should be made occasionally for the encouragement of teachers, and there are many of them, who are interested in science but whose research is largely in students rather than in subjects, whose publications of scientific papers may not bring them distinction, but the results of whose labors entitle them to recognition as at least indirect contributors to the promotion of science. Surely the effort to contribute something to the promotion of science is a worthy one.

I trust that you will pardon me for confirming this statement and closing this paper with a quotation from an address delivered recently to American chemists by the greatest organic chemist living today, Professor Richard Willstätter, of Munich. I wish that every teacher of science might catch the full import of these words:

"In twentieth-century Chicago, in *A Century of Progress*, we recognize better than anywhere else the significant dualism of spiritual and of scientific endeavor. Has mankind really progressed through the centuries in art, philosophy, morals, ethics, tolerance, humanity—in one word, in religion? It seems to me that each generation and each individual must start anew and develop in certain aspects its own ideas, its own standards, and its own faith. Thus the contrast between human nature and technical development is steadily increasing. I agree with Sarton, the historian of the exact sciences, when he writes: 'The acquisition and systematization of positive knowledge is the only human activity which is truly cumulative and progressive.' Constant and permanent progress is only achieved in science and its applications—industry and medicine. We all have thousands of great teachers and we ourselves contribute to the growth of the structure of fundamental and applied science to greater height. Oftentimes we may ask ourselves with severe scruples: Is mankind really becoming wiser, better, and nobler? Has the power of religion grown to render impossible hate and strife between races and nations? Let us wish that religion attains the goal of blessing mankind with love and peace. The ever increasing beauty and power of science are manifest. While I hinted at the contrast between the spiritual and the scientific, I strongly sense that which is common to both religion and science. Both are truly international, both serve in the end the common weal of mankind."