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THE TEACHING OF BOTANY—APPRAISAL AND FORECAST

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In undertaking a discussion of biology in education it is highly desirable to view the subject against the general background of American education as a whole. Among the nations of the world, the United States possesses the unique distinction of having mass education. We owe this policy to the shrewd foresight of the fathers of the American revolution, to their recognition of the fact that the success of representative government depends upon an enlightened electorate. As an object of primary importance, George Washington enjoined the new nation to "promote institutions for the general diffusion of knowledge." In his first inaugural address he stated that "as government gives force to public opinion, it is essential that public opinion should be enlightened." Though we as individuals commonly regard education as a means of improving our economic status, American statesmen have never lost sight of its greater importance in making democracy feasible. Because the civic value of education far transcends its benefits to the individual student, a system of free public was established and the education made compulsory.

Both the broad, civic function and the service of education to the individual currently engage the attention of public officials and educational administrators in an attempt to make both purposes more effective. The opinion is widespread that our public schools have failed to awaken an effective interest in public affairs and that they do not properly prepare our youth for self-support. Generally speaking, most of us will probably concede that it is worth while to improve the effectiveness of our public schools in these areas.

An over-all view of the present social order discloses that we live in an era of technology and invention. Technological advance has been so remarkably rapid that our social economy has been unable to keep up with it. The general mechanization of industry and agriculture have created serious problems of unemployment and economic maladjustment. Up to the present, our social wisdom has obviously lagged far behind America's scientific and inventive genius.

The solution of the problem is not a declaration of a morator-

ium upon science but rather the discovery of ways to prevent recurrent upheaval of our entire economic system in the wake of each new technological advance. We are confronted with the necessity of making social adjustments concurrently with rather than long after industrial advances. The existence of these conditions explains the desire of statesmen and educators to awaken a greater public interest in and to improve understanding of politico-economic problems thru the instrumentality of our public schools.

As a forecast, it looks like the American public is in for a rigorous course of instruction in the social studies as these relate to economics and political science. J. W. Studebaker, the present United States Commissioner of Education, has recently said that "It has been one of the chief concerns of the United States Office of Education in the past few years to promote civic education, not because other phases of education are not vital and important, but because civic enlightenment is now crucial. Without it we shall lose the freedom to educate and slip back into a dark age of partisan domination and severe restriction of the learning process itself." (Education Moves Democracy Forward, Columbia University, 8/17/39). This trend in American education will be given additional impetus by the social readjustments destined to emerge from the present world conflict.

The tendency toward increasing emphasis on social studies naturally has already had an influence upon biology as presented in our public schools. Current interest tends to center increasingly in those phases of biology which underlie legislation and social usage in relation to man, agriculture and medicine. Eminent civic leaders and school administrators have recommended that biology and science education be reorganized to present them in their bearing on social action. Perhaps this sounds as if biology is destined to be the tail on the sociological kite and that biology will occupy only a subordinate place in the educational picture. Rather the contrary. No one will dispute that the social sciences rest largely on a biological foundation and the better that foundation, the more effective will be the sociological program based thereon. This is but another way of stating that biology is the logical starting point in what promises to be the major educational emphasis resulting from the present world crisis. This new interest in biology will be added to man's ever-present interest in himself as a living organism.

One reason that the momentum of the existing trend toward

biology has not been more widely recognized in educational circles is that mechanical and technological innovations are more spectacular and they thus tend to overshadow recent yet epochal advances in biology. Technology overshadows biology especially in time of war. As the backwash of war and post-war reconstruction engulf us, however, there will occur a shift in emphasis from technological to social values. In war, mechanical and industrial products are paramount; even human life becomes a minor consideration. In post-war readjustment, however, the human element again becomes dominant and draws biological considerations of all in its wake. Many of us still remember this trend in education as an aftermath of the last war.

Turning specifically to the biological values which apparently will rank high in our future social life, I would place human well-being first. Prime among the social values will be the *health* of the nation. Need for greater conservation of human health has already become painfully evident in the rejection for physical disability of about 30% of the draftees called up for armed service. The estimated cost of medical care is $28 per capita or about $100 per family annually in the United States, a cost which reaches an aggregate of three and one-half million dollars or about five percent of the total national income. After all, children are America's most valuable crop and in the future as a matter of national economy we need to do a better job of caring for them than we have done in the past.

The importance of biological education in this movement is readily evident. The care of the human body will receive more attention in schools than ever before. Greater and more widespread knowledge of diet, housing, and health will be disseminated in our schools to parent and youth alike. The biology teacher will in the future be called upon to assist much more extensively with the scientific phases of public health and recreation. Food as it relates to better health will entail changes in the dietary habits of the nation and such changes will serve to focus interest upon human nutrition and the science of agriculture. Recent advances have already given a notable impetus to genetics as it relates to heritability of human disease. Over 100 defects of skin and eyes alone are now known to be congenitally transmissable. Heritable tendencies to diabetes, tuberculosis, asthma and allergy are also known. There is already an increasing demand for biology teachers familiar with the latest scientific developments in these areas.

These are but a few of the new developments already on the biological horizon.

These trends will also affect the future training of teachers. Biology teachers will find a practical inducement to acquaint themselves with the social sciences as they embody applications of biological principles. Professor John Dewey has stated that "the responsibility for a system of education akin to the method of science lies with those who already enjoy the benefits of special scientific training." It may, consequently, be the better part of wisdom for science teachers to become familiar with the major problems in the social area in order to inject more science into that field than to absorb sociological concepts into pure biology. Considerable confusion already exists, for example, in the field of eugenics because the biology of that subject is not clearly enough differentiated from its purely sociological aspects.

As one turns from the broader civic aspects of education to those dealing more specifically with the individual student, he also finds significant changes under way. These involve two major innovations in method and content. In connection with educational methods, it may be pointed out that certain as yet inconspicuous but nevertheless widespread tendencies have been gaining ground. There exists a definite movement in the direction of a balanced earn-learn program. This idea of providing job experience as an integral part of the student's schooling is by no means new and it has long been successfully practiced at the well-known Berea and Antioch Colleges. This policy, of course, has as its prime objective the immediate employability of the high school and college graduates and overcoming difficulties in obtaining their first full time job. The significant recent development has been the rapid expansion of this method of education, fostered largely thru outside subsidy as part of the national youth program.

The earn-learn program envisions enlarged opportunity for complete or partial self-support while the student is in school. Self-support is intended to provide not only the means to education itself for those who would otherwise be barred, but to introduce the elements of morale and job experience as well. As one scans census figures, it is evident that much needs to be done to make education accessible for some 3½ million youth who are not able to afford a high school or college education. Only 11% of our college age population are actually enrolled. Of the 21 million high school and college age group, nearly two thirds are excluded from schooling by pitifully small financial margins. Most

of the 13 million out-of-school youth were unemployed and, ironically, often prevented from obtaining jobs because of child labor laws. The very laws which had been ideallistically enacted to prevent industrial exploitation of children, in the depression boomeranged viciously against the very group they were designed to protect. America was rapidly recruiting a vast army of disillusioned adolescents who were fast becoming militant in their desperate discontent.

The crisis was becoming nationally acute and the federal government stepped in at this juncture to head off the possibility of American fascism and communism. The National Youth Administration was started in 1935 as an emergency relief measure for the purpose of eliminating school age children from the labor market by financially subsidizing their return to school. It is interesting to note that with an opportunity to earn from five to twelve dollars per month, 650,000 children were restored to school. The Civilian Conservation Corps with similar objectives was also inaugurated by the federal government. As a job training project the CCC has proven highly successful and has enjoyed about a 40% annual turnover due to acceptance of permanent employment. On the other hand, jobs have been found for only one percent of school age youth on federal unemployment rolls. The CCC obviously possesses spot-value job training which the public schools lack.

As a relief measure, the federal government thus came into American education on a large scale for the first time in the nation's history. As unemployment diminished both the NYA and CCC have been continued largely as a nation-wide experiment with the earn-learn program. Both of these agencies have recently passed to the jurisdiction of the United States Office of Education and thereby become an integral part of comprehensive national youth program, which can be quickly put into operation if post-war exigencies require. It is very possible that problems similar to those of the depression may again arise with collapse of the present war boom.

One may ask how this shift in educational method will affect biology. The answer may prove to be that biology will be called upon to help create opportunities for gainful student employment in its applied phases, especially for those students who contemplate a vocation in this area of science. Formulation of details for such a program may not be difficult in vocational high schools and

agricultural colleges, but real administrative ingenuity may be required to create such projects in our liberal institutions.

The inducement to find means of self-support at job training tasks for our students will probably come in the form of outside subsidy. The celerity with which we discovered all sorts of part time jobs as soon as NYA funds became available to our schools implies that no serious problem exists when there is a will to face it. Our NYA students have not only done much good work for us but the very existence of their projects has enabled many of us as teachers to obtain new facilities for practical work. Many of us have, for example, for the first time obtained a patch of ground for a garden and a greenhouse for utilitarian activity. The current shortage in important medicinal plants has already provided the impetus to hundreds of highly practical, self-liquidating drug-garden projects throughout the country.

The garden and other practical plant projects under governmental sponsorship has reciprocally created a demand for courses in applied botany. To a large degree classwork has moved from the laboratory to the greenhouse and to the out-of-doors. Such botanical information is much more exciting to the student because he acquires it himself instead of thru the textbook or lecture. Despite the informality of method, substantial quantities of sound scientific information appear to be gleaned under such informal auspices.

Obviously, if the earn-learn program is expanded and the methods of classwork become less formal, there is bound to be a commensurate effect on subject matter itself. Such tendencies are already evident on the plant side of biology, as can be readily gleaned from recent textbooks. We are, in fact, beginning to humanize the textbook and syllabus. For example, instead of tossing the leaf, stem, root, flower, fruit and seed at our classes like the pieces of a jigsaw puzzle and trusting to luck that the student will succeed in constructing a plant out of these parts, modern botanists present the plant as an entity by adoption of the developmental approach. The living plant, which has long threatened to come into the class room, has at last actually arrived—and with it an amazing increase in enrollment.

Students obviously prefer to work with the living plant, to start with a seed and to make it grow. These living cultures soon become personal pets and the student unconsciously responds to the subtle lure of life unfolding in his care, even if only in an or-

dinary flower pot or aquarium. Incidentally he always has the entire organism before him instead of as a miscellany of its separate parts. Experimentation with the living plant becomes something like manipulation of a mechanical gadget and provides abundant opportunities for student activity. The developmental approach with living plants readily sets the stage for the introduction of the functional side of applied botany better than the traditional structural departure without in any way excluding cultural phases of the subject. The developmental approach also makes it easier to keep courses student-centered instead of subject-centered.

I might add that recent developments in plant science offer the biology teacher a number of novel, yet definitely scientific experiments. The lay press has, for example, built up widespread interest in soilless culture of plants, a procedure readily adaptable to the classroom. Students are amazed by what they themselves can accomplish with a lot of water, and a few pinches of ordinary salts. Soilless cultures lend themselves not only to actual demonstration of symptoms of common nutrient deficiency diseases of plants but also to spectacular demonstration of recovery when the missing chemical elements are restored. Such experiments can be combined with studies on the effects of plant hormones and vitamins. Production of fruits by use of hormone smears instead of pollen is readily feasible and the seedlessness of such fruits creates enough interest in reproduction to enable the teacher to get across the scientific aspects of the process.

A graft of a tomato scion on a potato root-stock is easily made to provide training in methods of grafting. The production of potatoes and tomatoes on a single plant, always arouses interest and vividly demonstrates that different varieties can be grafted, as is commonly done in commercial horticulture. Herbaceous grafts are simple yet demonstrate basic practical methods. Such plants grow rapidly and results are evident much sooner than in woody species. Quick results are a great convenience to teachers charged with responsibility for the care of experimental materials.

Most students have heard of the use of canaries in warning miners of the presence of monoxide gas. Few students, however, have seen the epinastic response of tomato plants as a test for gas leaks, a demonstration easily obtainable in an ordinary laboratory period. In fact, one can go farther and by the same test demonstrate the natural emanation of ethylene gas from ripe apples. Such experiments set the stage for a discussion of the

commercial process of coloring and ripening of fruits such as bananas and citrus by ethylene gas. These are but a few specific illustrations of contemporary biology capable of providing effective, dynamic classroom activity.

If the earn-learn program, with its less formalized classwork and emphasis on functional values is to dominate post-war education, the teaching of biology can be readily adjusted to it and itself be vitalized. Its diversified character will be new and as such refreshing to those of us who have so long employed the older morphological approach. Diversity of activity and the evident logic of development as obtained with living organisms will place a premium upon good pedagogy. The fine, subjective art of teaching will in the future have to be more subtly merged with presentation of the strictly objective facts of science. Consciousness of the need for skill in teaching and the dissemination of the newer facts of science seems to be reflected in the recent organization of progressive associations for science teachers and the establishment of current periodicals devoted entirely to the particulars of teaching in this field.

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