School Biology of the Future: Some Considerations

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The distinguished Past-President of NABT looks into the future of biology teaching and presents thoughtful comments about the factors influencing its future.

In preparing this article on the biological education of the future, my first step was to limit the future to the next generation. However, even with such a limitation I found myself unable to draft a satisfactory statement because of the uncertainties associated with many of the factors that would impinge upon that biological education. It occurred to me that a brief analysis of some of those factors likely to influence future biological education, with perhaps an estimate of the degree of thrust those factors might have, would be of interest to readers of the *American Biology Teacher.* Thus, I am trying to identify and comment on some of the processes that will affect the school biology of tomorrow, rather than to describe what that resulting biological education might be like.

New Knowledge

The new and exciting knowledge being accumulated by biologists will have a marked effect upon the biology taught in the schools during the coming generation. Many teachers will be inclined to include more of the spectacular developments about messenger RNA, DNA, and other aspects of molecular genetics. Entirely new fields of inquiry can be expected from the recent work on the biochemistry of the defense secretions of insects, which could give rise to interesting theoretical considerations about the evolution and distribution of molecular compounds among organisms, on the one hand, and stimulate a completely new line of approach in the development of insecticides, on the other. There now exists a series of absorbing developments in the field of animal behavior which, while already considerable, are only just beginning to enter into curricular considerations for the schools. A deeper insight into the photosynthetic process is sure to come. Because of the pressures upon man in an increasingly urbanized society, more attention will be devoted to population problems and pollution control, which will lead us to penetrating investigations into the fundamentals of biological populations and ecology.

Many instructors will express concern that these new areas of biological knowledge, and others we cannot now even dimly perceive, should not displace from the classroom some of the great values of our classical biology. Of course, the classical connotation itself is undergoing considerable evolution, and it seems certain that much of the sparkling new knowledge creeping into textbooks in the 1960's will be considered classical by the 1980's.

Philosophy of Teaching

It seems reasonably clear that the biological education of the near future will place increased stress on inquiry and discovery. For all the reasons now widely discussed which have led to the present efforts to alter our science curricula, the methods of teach-

ing will inexorably change. There will be less attention paid to the accumulation of factual information by students and more to an understanding of the organization and philosophy of the science, with particular stress on how information is obtained. In this connection, it might be recalled that during the first third of the current century the biology taught in the schools was dominated by a phylogenetic approach; the school biology of the mid-third of the century was dominated by a presentation generously called a principles approach, in which a series of topics such as, heredity, health, and biological organization, was superimposed on the phylogenetic approach; and it seems that the last third of the century is to be dominated by an inquiry approach. The last transition actually represents a discontinuity which makes the adoption of the new methods unusually troublesome and challenging.

Curriculum Study Groups

The major curriculum study groups such as the PSSC, SMSG, CBA, CHEMS, BSCS, ESCP, and others have had an enormous impact, overwhelmingly for the good, on our changing science curricula. If society can devise ways to extend these groups, or replace them with comparable groups, we can expect our biological education to continue to improve and flourish. For these study groups to be of maximum effectiveness, it will be necessary to continuously replenish their memberships, so that the participation of large numbers of persons can focus a great diversity of talent on the improvement of biological education. The enthusiasm for the continuation of such groups is strong in the biological community, a fact which bodes well for the future, but the support upon which the groups depend for their existence is indeterminate at the moment. If the curriculum groups do nothing else during the immediate future but accelerate the transmission of information from the frontiers of the research laboratories to the classrooms of our schools, they will be serving a very worthy purpose. It is important for the welfare of the nation, as well as for the benefit of individual citizens, that this rate of transmission be selectively increased.

Government Participation

The role of the Federal government is already extremely complex and is likely to become even more so. As an example of the complications and their potential adverse affects on biological education, one could note the relative decline in funds currently being given by Congress to the National Science Foundation and the great increase in funds being given to the Office of Education. There seems to be a feeling among some persons in the NSF, that, in the light of these shifting appropriations, the Foundation should devote less of its limited resources to science education, thus providing more adequately for science research and facilities; at the same time, many persons in the Office of Education indicate that science education has been reasonably well supported in the past and so they suggest that the primary responsibility of the Office should be to other areas of education such as the humanities and social sciences. The net result is likely to be a very substantial drop in the level of Federal support of science education, which would be completely contrary to the real intent of Congress. An inherent danger in such a situation is that gradually diminishing support would not be sufficiently dramatic to attract the attention of the responsible officials, and communications between some of them and a few individual science educators would not be likely to reverse such a trend.

The wide variety of Federal programs under way, such as the support of institutes for teachers, facilities for schools, and construction of buildings will certainly have a very favorable impact on biological education. There seems to be a growing interest in the support of teachers on a twelve-month basis, requiring, as part of the employment, that some part of the year be devoted to study and intellectual refreshment. Such a system has been established in many of the prefectures of Japan and might well be supported here through government funds within the foreseeable future. It seems clear that the Federal government could play an increasingly supportive role in biological education without infringing upon the area of content determination.

Teacher Training

Many highly qualified teachers have been educated and trained in our universities and

colleges, but there are also many who are not being prepared to handle the new biology, and the still newer biologies that will form the components of our educational programs in the future. One of the fundamental problems here, is the rather general failure to distinguish between the roles of a college professor and of a high school teacher, the first being essentially a scholar of science, and the second essentially an interpreter of science. Failing to take this difference into account, many of our teacher preparation institutions currently prepare prospective high school teachers as if their future role were to be college professors. There seems to be little awareness of this deficiency which could be increasingly deleterious.

Yet the future is not without hope, because there are signs indicating change. The growing numbers of college biology professors and of professors in teacher training institutions, actively working with high school teachers in the design and testing of curricula, are likely to result in the gradual improvement of the preparation teachers receive in our universities and colleges. Another related factor is the emergence of junior colleges and community colleges which are creating a greater mobility of instructional personnel between secondary schools and institutions of higher education.

Effect of Inquiry Teaching

It must be recognized, of course, that there are limitations to the impact of the inquiry orientation of the new science courses. Not all students are enrolled in such courses. And many teachers are teaching in a traditional fashion, even though they hold new inquiry-oriented books in their hands. In addition, many youngsters appear to be peculiarly resistant to the most earnest efforts of competent teachers, and appear to profit little from our present best inquiry instruction. Furthermore, if a good student is fortunate enough to have a good inquiry-oriented biology course from a good teacher, this instruction amounts to only five per cent of his secondary school education. Despite all of these qualifications, as time goes by, a higher proportion of our citizenry should consist of persons who have been more or less influenced by inquiry-oriented education. Perhaps it is slightly more than a pious hope that such citizens would contribute more effectively to our educational systems than is now the case, and would thus make our classroom programs more adaptable to the needs of our children and our society. What I am trying to suggest is that the inquiry approach now trickling through the schools may lead to substantially greater sophistication among the leaders of tomorrow, with broad resulting benefits, including improvement of our future educational endeavors.

Cognate Fields

Concurrently with improved education in the biological sciences, there will be improved education in the physical sciences and mathematics, and this should provide a more favorable climate for biological education in our secondary schools. Interesting pioneer efforts at interdisciplinary science courses can be expected to emerge at the secondary school level and may result in significant challenges to those who now prefer to have the life sciences and the physical sciences taught separately.

Elementary and Junior High School Science Programs

Biology is taught in our schools today largely as if no science instruction had preceded the tenth grade. Many educators have been pleading for a continuously articulated science program from kindergarten through high school and some small steps are currently being taken towards this goal: a number of earnest and competent scientists and educators are working on improved materials for elementary and junior high grades. With more seriousness than ever before, we are asking ourselves what level of attainment we should reasonably expect at particular developmental stages or grade levels. If these many elementary and junior high efforts are as successful as we hope they will be—and the intensity of this work is increasingly markedly—there will be a substantial impact on the kind of biological education that can be presented in the high school. Students will come into the secondary schools with a higher level of scientific sophistication, and many topics now treated in the secondary school curriculum would have been explored in earlier grades. For example, it seems obvious that certain applied aspects of health

should engage a child's attention at an early age and so, also, should an acquaintance with, and appreciation of, living organisms.

Museums, Zoos, and Television

The instructional efforts represented by displays in our great natural history museums and zoological and botanical gardens are, roughly, in the phylogenetic-stage of education that our schools were in 40 years ago. In only a very few places are the programs of these institutions gradually attaining the "principles" stage of education. The zoos, botanical gardens, and museums are the sleeping giants of American biological education, and they have a tremendous potential contribution to make to the future of biological education. If these institutions, with their vast resources, are able to break through to a new level of educational endeavor, the effects on the schools could be substantial. Similar observations could be made about television, although from a rather different perspective.

Learning Theory

Generally, learning theory seems to be following, rather than leading, curriculum development. For example, the PSSC course was designed with particles and wave motion as a central core; one of the chemistry courses was organized around properties of chemical bonding; and nine basic themes were woven through the BSCS courses. As these various courses were being tested and developed, leading psychologists were expressing the view that a major goal in teaching science to children should be to instruct them in the structure of the discipline. Thus, the psychologists were proposing as theory what physicists, chemists, and biologists were already practicing.

Learning theory could be far more useful in the preparation of better materials for the schools if it could precede, rather than accompany or follow, new curriculum developments. Perhaps this is too much to expect, since the schools themselves must serve as the ultimate laboratories for the testing of propositions constructed by learning theorists and other educational investigators.

Private Foundations

The role of private foundations in the improvement of biological education seems to be diminishing, and it appears unlikely that they will have a significant contribution to make to the development of that education. Yet it is possible that a sharp change could occur if the present confusion among Federal agencies should threaten to result in diminished support from the Federal sector for experimentation and improvement of biological education.

Private Enterprise

Perhaps the greatest imponderable concerning the biological education of the future is the role to be played by the new educational corporations resulting from the mergers of electronics companies, publishers, film makers, supply houses, testing services, and other educational and para-educational concerns. One could envision that such new corporations could greatly improve biological education. For example, such a corporation could afford to hire the most highly qualified people to design a series of courses from existing and new materials. From such blueprints, a teacher should be able to select a particular course, with flexibility and options, that he would like to teach. Upon notification of the corporation, there would arrive automatically at his school, at the proper time, a series of textbooks, films, live animals, live plants, remedial programs, examinations, and all the other attributes necessary for a well-conceived and highly personalized presentation. From a purely practical point of view, if for no other reason, this idea is extremely attractive, since such educational services could constitute an enormous contribution to teachers generally. It would make it unnecessary for thousands of teachers across the United States to study biological supply catalogs, equipment catalogs and film catalogs, and to run petty errands for minor pieces of equipment and supplies. The savings to the nation's biology teachers, in time spent in these organizational matters, could be very considerable and the added efficiency of group purchasing could result in tremendous savings in costs.

The dangers of the system are, perhaps, more obvious. The ruthless efficiency with which such a system could be organized might tend to overwhelm many teachers, and force them into patterns of education

that they would not otherwise consider to be optimal. Still more dangerous is the possibility that the policies of such corporations would be controlled by men of commercial mien who would view education more as a big business and less as a responsible service. If the program designed by such corporations were not in the hands of competent educators, the system could be a great deterrent to the advancement of education in this nation. The key question will clearly be who would be making the key decisions.

If educational goals are subverted by big business practices, there could develop a very serious crisis inviting public attention. It would be paradoxical, indeed, if the movement of giant corporations into education led to Federal control of education.

Laboratory Manual in Animal Behavior

In response to a widespread need, the Animal Behavior Society is preparing a *Laboratory Manual in Animal Behavior.* This will contain 50-75 separate exercises relating to all aspects of animal behavior and suitable for use in courses in animal behavior, general zoology, entomology, ornithology, etc. To make the manual fully representative of all animal groups and to cover the important behavioral concepts, the Society is requesting interested individuals to submit laboratory exercises they have found successful. Each exercise should include the following: Introduction to the problems or concepts to be studied; procedures in sufficient detail so that inexperienced students and instructors can carry them out with high expectation of successful outcome; a series of questions to direct the student's observations and thinking; and selected references to pertinent studies and films. Exercises will be most valuable if the cost of equipment is modest and species to be studied are readily available.

Exercises may require anywhere from a single laboratory period up to a full semester for completion. Experiments may be on one or several species. Contributions to the manual will be paid for through anticipated royalties. Each exercise will carry the name of the contributor.

Those who wish to contribute should send a 1-page summary of their proposal stating the principle illustrated, equipment and procedure, directly to the Editor: Dr. Allen W. Stokes, Department of Wildlife Resources, Utah State University, Logan, Utah 84321.

New Junior High School Science Project

A mimeographed publication, "Michigan Science Curriculum Committee - Junior High School Project," and subtitled, "The Development of Junior High School Science Activities," has been published by W. C. Van Devanter, Western Michigan University, Kalamazoo, as Director of the project, and Robert R. Sternberg, Michigan State Department of Education, Lansing, as Co-Director. It is an unusually fine source of laboratory exercises for the junior high school science course. The project was supported by the U. S. Office of Education.

Courses on Chemical and Biological Defense

A series of one week courses is being offered to develop a Chemical and Biological Defense capability among public health and medical personnel. The training, which is sponsored by the Division of Health Mobilization of the Public Health Service, will be held at Fort McClellan, Alabama.

Participants will be persons whose positions require knowledge in Chemical and Biological Defense. They will include representatives of state and local health departments, faculty members of schools in the Medical Education for National Defense Program, Veteran's Administration, Public Health Service, and other interested people. Official application forms are available at the Training Branch, Division of Health Mobilization, Public Health Service, U.S. Dept. of Health, Education, and Welfare, Washington, D.C., 20201.