

# The Education of Secondary School Biology Teachers

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Given at the NABT meetings with the AAAS in Denver, December, 1961, the author is a Professor of Education at Stanford and associated with the BSCS. In the paper, Dr. Hurd argues eloquently for a completely new look at biology teacher training by presenting the situation today and making some pertinent suggestions for its improvement.

## I

With the development of new curricula in science there is a compelling reason to re-appraise the training of biology teachers. The problem is deeper than can be met by any realignment of the existing academic and professional pattern of courses. The importance of education as a factor in the economic growth of America; the increasing demand for technically trained manpower; the rapidly advancing frontier of research in biology; and the changing structure of biology all point to the need for a different kind of teacher education,

The goals of secondary education as well as the purposes for teaching biology in the high school are changing. There is the point of view that a biology course should be of intellectual service to a student for his entire life and that we can no longer afford courses which have only an immediate value. Developing an access to new knowledge has become a more important goal than making an inventory of the old. Recent data on the learning potential of young people and new insights into the process of instruction suggest that more sophisticated concepts of biology can be effectively taught than has heretofore been attempted.

Almost any suggestion for the improvement of biology teaching comes back to the problem of improving teacher education. It is my feeling that we do not really have many programs for the education of biology teachers in America. There is a biology major in most colleges and universities; if one pursues it for two years, he is a technician; for four years, he is a teacher; and for seven or eight years, he is a researcher. The sequence is the same for all, only time identifies the career choice. The special demands upon the discipline for the teaching of high school bi-

ology are seldom recognized. The assumption that the best education for a teacher is that of a researcher, only less of it, is untenable.

Seriously needed is a pattern of teacher education in biology that is appropriate to the work that a biology teacher does. And by this I mean what the *ideal* teacher does to achieve the goals of a modern course. A high school teacher's function is primarily that of an interpreter of science. It is his responsibility to develop biologic literacy in the high school population. This means that young people should leave a course with an appreciation of the nature of biology and its modes of inquiry, and with an understanding of its major theories and conceptual inventions. To offer a first course in the professional training of a biologist is *not* the job of a high school teacher.

My critical remarks are focused upon the system of teacher education and not upon the individual teacher. If it is true—and some critics would have us believe it is—that the competent, well-trained, scholarly high school biology teacher is a species that faces extinction, then it is my feeling something is wrong with the breeding grounds. If a freshly graduated biology teacher can do no better than teach a thin, truncated copy of his college courses, and if his only intellectual security is found in a textbook where the chapters are abbreviated replicas of his college courses, it is the educational program and professional standards that are at fault.

There is no simple solution to the problem of producing better biology teachers. "Raise salaries," "up-date the teachers," "minimize methods courses," "broaden liberal education," "increase the number of semester units for a major in biology," "reduce the teaching loads," "better text-

books," "improved laboratory facilities and more equipment" are naive suggestions, though each may have some merit. Nor is there much reason to suspect that we will soon find an electronic substitute for biology teachers: television, teaching machines, tape recorders, and filmed lectures; these devices are best used by the already capable teacher. "Team teaching," "core programs," "rotating schedules," "track systems," "longer school days," and the "extended school year" have nothing inherent in them that will help teachers convey to young people the logic of biology and its investigative procedures. One is reminded of the farmer who paints his chicken coop in an effort to improve the egg laying quality of the hens.

There have been numerous studies on the tenure, training, characteristics, and duties of biology teachers. These data are interesting and may be useful in planning a program of teacher education. They are presented here as background for the discussion that is to follow.

1. Over 80% of the teachers with a *major* in biology are graduates of liberal arts colleges and universities.
2. Of the 120 semester credits typically required for graduation with an A.B. degree, 18 of these will be in professional courses including the credit earned for pre-teaching observation and student teaching.
3. Practically no biology teacher has ever had a methods course on teaching the subject. With the exception of several resource books there has not been a methods book on teaching biology published within the past twenty years. About half of the biology teachers, however, will enter teaching having had a general methods course on science teaching and half will have had no guidance whatever.
4. The average teacher of biology has 20 semester credits in the subject; teachers in larger high schools average nearly twice as many and nearly all fall short of the minimum of the 50-60 units suggested by various national committees. Five per cent of the high school biology teachers have never had a college course in biology.
5. It appears that 50% of those teaching biology are biology teachers by an administrative decision made at the school level and that no college or university in any way or manner has recommended these persons as biologists. Biology in most instances is not the first interest of these teachers.
6. The overwhelming majority of all college biology graduates and at all degree levels become teachers in high schools, junior colleges, state colleges, liberal arts colleges, or universities.
7. About 25% of the high school biology teachers teach only biology. This is a better record than that of the teachers of the other secondary school science subjects.
8. Forty per cent of the college graduates who are certified to teach a high school science do not do so upon graduation.
9. The teacher turn-over per year in science, due to all causes, is 10%. If we assume it takes at least five years of experience to develop a top-rate biology teacher, this means that at any one time about 50% of even the qualified teachers are novices.

This is a rather ugly picture but no more so than are many of the unsolved problems in science. The shortage of qualified biology teachers is representative of the generally short supply of technically trained manpower in the United States. Solutions to many of these problems can evolve from experimentation and the invention of more appropriate biology and professional courses for the education of teachers. The snide remarks of unqualified critics, the public harassment of classroom teachers, meaningless educational slogans, the laissez-faire attitude of academic biologists toward teaching, and the disinterest of biology teachers for the advancement of their own profession have done their damage. I suggest we adopt a more positive attitude and attack the problems in a manner that behoves those whose training has been in the sciences.

## II

The problem of teacher preparation in biology is complex with many interrelated facets. Initially we must know the nature

of the educational program for which teachers are to be prepared to teach. The activity of the BSCS in clarifying the goals of high school biology teaching, in producing a series of modern courses, with supporting laboratory experiments, and in developing related instructional materials provides one direction for the education of biology teachers. There must be perspectives from which to work if a sound pattern of teacher preparation is to be evolved. The lack of any clear rationale results in either a random assortment of courses, or what is just as bad, a concentration of courses only partly related to the teaching of a high school biology course. Academic majors, for example, that are 75% botany or zoology or physiology or bacteriology are inappropriate for the work of a secondary school teacher.

Teacher education is an all-university function. The biology department is responsible for the specialized knowledge; the education department for professional training; the liberal arts faculty for the cultural background needed by any scholar; and all must work within the framework of a unifying theory of teacher education. Then the high school has the responsibility for perfecting the raw product that comes from the university. It seems unlikely that the colleges can ever hope to do the complete job of preparing a teacher if for no other reason than that teachers are perfected by teaching; they are not graduated. There is an over-arching aspect to the process of developing teachers: at all points the prospective biology teacher needs to be in contact with good teachers because one learns to be an effective teacher by being well-taught.

A good teacher *is* competent in his knowledge of biology, and he is educated far beyond the level he is expected to teach. The depth of training for a biology teacher must be sufficient for him to understand the nature of the discipline, its substance and its methods. He must have some insight into the problems at the frontier of biology and possess an understanding of the events that caused these problems to emerge. His training must be such that he is qualified to do graduate work in biology and to participate in curriculum improvement in biology.

What will it take to get some of these

results? Various committees have identified courses and suggested patterns for organizing the teaching major in biology. There is the need for departments of biology to take a positive interest in the training of teachers. Evidence of this interest will be found in the new courses that are created to meet the special demands of teachers. One of these could well be an advanced course or seminar in *general biology*, one that provides a synoptic view of the discipline and is offered after the student has a background in the subject. The career of a biology teacher consists of teaching a course structured to present a coherent picture of biology; yet he is quite likely to be the very one who has never experienced such a course at the college level.

To understand the nature of science and its modes of inquiry has become a major objective for the teaching of biology. However, whatever training one usually gets in these terms comes through a process of intellectual diffusion between advisor and candidate at the doctoral level, it is not a part of the high school teacher's education. In fact, the men best qualified to impart this understanding, the active research biologists, are the most inaccessible for the training of teachers.

The faculty of a biology department has the responsibility for the training of teachers in the use of the tools and techniques required to do biology. The preparation of materials, maintaining cultures, and the use of biological equipment need to be taught in the courses where these are normally used. A part of this knowledge should be acquired in laboratory work that has some of the characteristics of an investigation.

The professional phase of teacher education in biology needs to be re-examined. The methodology of teaching any subject is inherent in the discipline. The mood and style in which biology should be taught is different from that of other subjects. The general methods course in the professional sequence is inadequate for the prospective teacher of biology.

It rests with those who specialize in science education to bridge the gap between the way the beginning teacher learned his biology and the manner in which he will need to present it to adolescents under conditions

of involuntary studentship. The teacher of biology requires special knowledge about the conditions and climate for effective learning, much more than "common sense" can provide. Educators may disagree on theories of learning; however, they are prepared to suggest at least minimal circumstances for improving the efficiency of human learning. It is significant in this regard that all of the national curriculum committees on high school science have developed courses that depend upon particular methods of teaching if the goals of the new courses are to be achieved. There has been a reluctance, and rightly so, to have teachers use these courses without training in the special ways they should be taught and learned.

The pre-service training of teachers must have a firmer theoretical basis. Teacher education is no more a "bag of tricks" and "rule of thumb" procedure than biology is a "barrel of frogs" and a "guide for dissection"—unfortunately there are those who would not argue with either of these positions. The practice of teaching is meaningless and inefficient without a foundation in well-conceived theoretical constructs. Theory in education has the same values that theory has in the advancement of science. There are teachers who feel that "theories don't teach classes, we need something more practical." This is the same restrictive attitude I found among the "practical dirt farmers" toward the college trained agricultural agents in the community where I first taught. Without a consistent point of view for the teaching of biology there is no intellectual guidance for the conduct of courses and the teacher does little more than comment upon the textbook. He is only a technician and his curriculum decisions are limited to tinkering. Good instructional practices have their origins in a systematic study of education and in its theoretical components. Otherwise, there are only clichés and folklore to guide a teacher's actions.

The in-service education of beginning biology teachers has long been a problem. Pre-service training is at best an abstract experience. Much of the course work must focus on the intellectual aspects of teaching. This means that the perfection of instruc-

tional methods must come in an on-the-job situation. The beginning teacher is just that; he is not experienced, he is not developed, his education theory is tenuous, and he is likely to be insecure in his teaching command of biology. He needs to be introduced gradually into full teaching responsibilities with the help of a master biology teacher who can make him aware of the avenues that will lead to an improved performance.

There are too many biology teachers doing a poor job because no one ever helped them do better at the time they could have profited from advice. The all-too-frequent teacher the largest class load, the most diversified schedule, the most difficult youngsters and the poorest classroom should cause us to rise in professional indignation. It is little wonder that the loss of first-year teachers is so large.

There is the question of how long it will take to develop a good biology teacher. The consensus from committee reports is that it will require at least five years of special and professional education. Another three to five years of in-service development then seems necessary, and this would include some time spent in advanced training. Part of the graduate work would be in the sciences and part in ripening the teacher's theory of science teaching.

The new goals for secondary school science teaching and the increasing complexity of biologic knowledge indicate a need to seek teaching candidates from the most alert, imaginative, and scholarly students that are to be found. The teacher we are seeking is one who has pride in the intellectual and scholarly life—we cannot afford those of less ability. Although the education of a teacher needs to be different from that of a researcher, the intellectual quality demanded for both careers should be the same.

There is much to be learned about how teachers should be selected and trained; unfortunately, there is at present a serious lack of pertinent research. The problems have been surveyed on numerous occasions, yet the investment in money and resources to work on these problems has been small.

The joint report of the American Association for the Advancement of Science (AAAS) and the National Association of

State Directors of Teacher Education and Certification (NASDTEC) lists eight guidelines for a program of teacher education in biology. These provide an excellent beginning point for the faculties of a college or university wishing to consider seriously ways of initiating an improved pattern of education for high school teachers of biology.

Guideline I: "The program should include a thorough college-level study of the aspects of the subject that are included in the high school curriculum.

Guideline II: "The program should take into account the sequential nature of certain areas, and in particular should provide the prospective teacher with an understanding of the aspects of the subject which his students will meet in subsequent courses.

Guideline III: "The program should include preparation in the subject to be taught, with courses chosen for their relevance to the high school curriculum.

Guideline IV: "The program should include sufficient preparation for the later pursuit of graduate work in biology.

Guideline V: "A fifth-year program should emphasize courses in the subject to be taught.

Guideline VI: "The program should include preparation in areas related to the subject to be taught.

Guideline VII: "The program should include preparation in the methods especially appropriate to the subject to be taught.

Guideline VIII: "The program should take into account the recommendations for curriculum improvement currently being made by the various national groups."

The complete report includes examples and specific suggestions for implementing each of these guidelines.

#### References

- American Association for the Advancement of Science and American Association of Colleges for Teacher Education, 1960. *Improving Science and Mathematics Programs in American Schools*. AAAS, Washington, D. C. 41 p.
- Brown, K. E. and Obourn, E. S. 1959. *Qualifications and Teaching Loads of Mathematics and Science Teachers*. Circular No. 575. Supt. of Documents, Washington, D. C. 101 p.

Conference on Nation-wide Problems of Science Teaching in the Secondary Schools. 1953. *Critical Years Ahead in Science Teaching*. Harvard University Printing Office. Cambridge. 48 p.

Garrett, Alfred B., Chairman. 1959. *Recommendations for the Preparation of High School Teachers of Science and Mathematics—1959*. *School Science and Mathematics*, Reprinted April, 1959. 281-289.

Hurd, Paul DeH. 1958. *Science Teachers for the New Era in Science*. *California Journal of Secondary Education*, 33 (8) 486-491.

NASDTEC-AAAS. 1961. *Guidelines for Preparation Programs of Teachers of Secondary School Science and Mathematics*. AAAS, Washington, D. C. 32 p.

Radcliff, Shirley. 1959. *Teacher Education Fifth-Year Programs, A Selected Bibliography*. Bulletin 1959, No. 9. U. S. Dept. Health, Education and Welfare. Supt. of Documents, Washington, D. C. 20 p.

Woodring, Paul. 1957. *New Directions in Teacher Education. The Fund for the Advancement of Education*. New York. 142 p.

### NABT California Conference

Regional Director John Bruce, San Ramon Valley High School, Danville, California, announces another NABT Biologists Conference on Behavior, April 7, Room 2000, Life Science Building, University of California, Berkeley. The program will include outstanding speakers on behavior in plants, insects, birds, animals, and primates as well as tours and demonstrations.

### Spring Wildflower Pilgrimage

The Botany Department of the University of Tennessee and several other organizations are cooperating again to conduct this pilgrimage. Some 500-700 participants are expected April 26-28. Registration fee is \$2.00. The registration begins at 9:00 a.m., April 26, at the Greystone Hotel Playhouse, Gatlinburg, Tennessee. Further information may be obtained by writing Department W. P., Box 527, Gatlinburg.

### European Education

Persons interested in the reforms and administration of European schools are invited to participate in a special tour November 9-26, 1962. Inquiries should be addressed to Dr. Harold V. Webb, 1940 Sheridan Road, Evanston, Illinois.