

THE CHALLENGE OF THE CRISIS IN SCIENCE EDUCATION¹

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The title of my discussion assumes that everyone is in agreement that a crisis now exists in Education in the Sciences, including Mathematics and Engineering. Before we accept this point, let me give a little bit of background data.

Although there seems to be little doubt that we now graduate fewer scientists and engineers than does Russia, this is *not* the major reason for our concern about shortages. We *are* concerned that in our own economy we cannot meet the demand for qualified persons. One can examine the want ad sections of large metropolitan papers and he must be impressed with the job openings listed, many with major responsibility for operations.

And the fact is that we can project population and enrollment estimates for a relatively long period without arriving at a point where supply will equal demand. A tremendous boom in industrial production has been developing from technically informed persons. An indication of this growth lies in the following statistics. For each person in the population of the United States in 1870 there are now 3.8 persons. We have had an increase in jobs so that now we have 4.7 persons in the labor force for each one in 1870. But for every person employed in Science and Technology in 1870 we now use 85 persons. Our technical society has expanded 85 times in 85 years.

Enrollments have greatly increased in the school systems at all levels. We now have many more students taking sciences. But the shifting emphasis on Science and Technology has not carried back into enrollments. The proportion of students enrolled in Sciences, including Mathematics here as always, has been drastically reduced—81% of high school students were enrolled in Science in 1910 and 52% are enrolled now. 89% of high school students were enrolled in Mathematics in 1910 while only 53% are enrolled now. In Physics the percentage has dropped from 16% to 4.6%. In the Biological Sciences the drop has been from 39% to 20% between 1910 and 1952.

The drop is even more drastic when we consider that the statistics now often include courses in remedial science and remedial arithmetic.

¹This paper was read at the dinner meeting of the Tennessee Academy of Science in Murfreesboro, November 30, 1956.

The significance of these data is obvious. With 85 times the use, we are not increasing the emphasis on training and we seem to be still losing ground unless spot checks of enrollments are correct for this fall in predicting that the upswing is now underway.

The fact is that, if we *do* have the upswing in enrollments, we are still unprepared for it. We know, within a close margin of error, how many children will be in high school and college for the next 15 years. They are already born. We know that college graduates cannot all go into teaching, yet this must be true or the quality of teaching will go down since we cannot otherwise meet the demand.

The training of Ph.D. teachers in college is easier to predict and let's take a look at this aspect of training. In 1954-55 a survey of colleges revealed that 38% of them had vacancies unfilled. If these and other vacancies are filled it means that by 1970 the present percentage of College Professors with the Ph.D. degree will drop by one-half—from 40% to 20% of the total teachers.

The extra college teachers will likely come from high school ranks to further reduce the available qualified persons at this level. It does seem that there is a real crisis.

As one attempt to meet this problem the Cooperative Committee on the Teaching of Science and Mathematics of the AAAS, with an active member from the Academy Conference, designed the Science Teaching Improvement Program (STIP). The Carnegie Corporation provided \$300,000 for a three-year plan which calls for activities of seven major kinds that may contribute to a more rapid solution to the problem. I will give a brief run-down of the areas and then report on the activities that are designed to operate the program.

The first activity assumes that scientists accept the existence of a crisis but need to be provided with information and a stimulus toward greater activities. We have interpreted this to include the widest possible dissemination of information by all means at our command with suggestions for individual action.

A second point recognizes that legal and administrative control of the education of scientists and science teachers lies with those persons trained as professional educators. We have felt that this necessitated cooperation with certification agencies, teachers colleges, teacher associations and similar organizations in the examination of existing training programs to suggest improved procedures that could result in better recruitment.

A third point is concerned with career pamphlets, guidance counselors, communications media and other means that are

used to sell various things. We are trying to determine which of the many approaches to motivation of students will yield the most results.

Salaries are the fourth item in the program. What are the salaries paid and what should they be? Should the federal Government be asked to subsidize salaries?

The fifth activity recognizes that a major problem exists in working conditions of teachers. Is the load too heavy? Is teaching equipment available? Is there good classroom space? Must science teachers also coach?

The next point is related to this one. The committee felt that consideration must be given to awards for excellence in teaching. Awards by scientists for good science teaching and the establishment of a corps of "Master Teachers" in Science and Mathematics should result in increased prestige and public recognition.

The seventh item on the STIP program called for an experimental study on the use of Science Counselors. The Universities of Nebraska, Oregon, Texas, and the Pennsylvania State University were each selected as "centers" for this study. Each center has hired two counselors with granted funds. These counselors are asked to work with high school teachers who want advice in the preparation and presentation of sciences and mathematics. They hold joint positions with the University and the State Department of Education in each state.

Obviously, this program cannot work in a vacuum. We are cooperating with many other agencies in Washington D. C., and elsewhere. We work jointly on a commission with the American Association of Colleges for Teacher Education. We share efforts with the National Academy of Sciences/National Research Council in several areas. We serve on committees with the U. S. Office of Education, the National Education Association, the American Chemical Society, the Mathematical Association of America, the National Science Foundation, and many other groups including the President's Committee on the Development of Scientists and Engineers.

I would like to report on the activities of many of these groups, although we carry administrative responsibility for only a few programs.

Since the difference between a teacher and a *Science* teacher or a *Mathematics* teacher lies in the number and kinds of college courses he has taken, we have assumed that all methods to increase the enrollments in science and mathematics must be considered.

At the undergraduate college level this could be most rapidly approached by means of scholarships or by increasing graduation requirements. The Congress is considering scholarships bills and many industries have a stake in this program. The STIP program has attempted to encourage all appropriate agencies to study graduation requirements and with the AACTE plans to provide for experimental programs of teacher certification with increased subject matter. Offerings by correspondence courses are being surveyed with the idea of adding good correspondence study courses to the existing programs.

After a certified teacher tries his course background in the classroom, he may decide that he needs courses in Science and Mathematics to improve his competence. Summer institutes are being given to meet this problem. A stipend is provided to enable the high school teacher to enroll in the courses. Money is given to the college for the development of courses. These courses in "modern mathematics" and "recent developments in chemistry" recognize the lack of previous preparation and become "beginning" courses. They recognize the mature teachers need a different course content from undergraduate students and move faster with a different approach to the problem.

These institutes are being given tremendous support next summer and next year. The National Science Foundation will spend \$9,750,000 on nearly 96 summer institutes, 16 year-long institutes and 2 or 3 evening institutes. Other major sources of support for these programs include The Atomic Energy Commission, the Shell Companies Foundation, the DuPont Company, General Electric, and Westinghouse.

Handbooks, teaching charts, sourcebooks and other curriculum materials are being produced in very large quantities. The Manufacturing Chemists' Association will spend an estimated \$1 million during the next five years to distribute companion teacher and student books, charts, filmstrips and the like to Elementary, Junior High and Senior High Schools. The National Research Council is producing sourcebooks for laboratory experiments and curriculum revision is the concern of many groups.

Fellowships for good *teachers* are now available through the National Science Foundation and through the Atomic Energy Commission. Summer employment for teachers is a national program of many industry groups and of several applied science laboratories.

In order to clarify the present picture and provide more accurate data for the future, the Office of Education has been given joint support by science groups to study the status and qualifications of science and mathematics teachers in the several states. A

comprehensive questionnaire study will soon be made and a pilot study of State Department records will probably be expanded to visit all State Departments and determine the availability of data on teachers.

Activities aimed at motivating Junior Scientists are being accelerated. The Future Scientists of America Foundation of the National Science Teachers Association (NSTA) has initiated a new student publication with papers by students. Street and Smith Publications has just embarked on a commercial venture of this type. Science Service has its weekly magazine in full operation. Career materials are distributed by NSTA, Science Service, the American Chemical Society, the U. S. Department of Labor, and almost every major industry. STIP is contemplating a community study of the impact of these materials on students. It is sometimes stated that career pamphlets have no more than a 1% effect on the students choice of a career.

The Junior Academies of Science have been given increased aid by the Academy Conference and the STIP program. A "Junior Academy Session of the Academy Conference" will be held in New York on December 28, 1956, to discuss the needs and the future of Junior Academies. A conference is being planned for Chicago in February to be supported by the National Science Foundation, where one representative from each state Junior Academy will discuss the problems of Junior Academies.

The Society of Sigma Xi has sent national lecturers out for many years. The National Science Foundation has expanded the use of these lecturers through the American Chemical Society, the Mathematical Association of America and the American Institute of Biological Sciences. The American Institute of Physics has been invited to make a proposal for support.

Many agencies, large or small, are providing consultant services to science fairs, industry tours, lectures, and various other services to the teachers. It is their hope that teachers will become more confident of public support and be stimulated to do a better job.

Certainly the secret of success of all the programs seems to lie with the teacher. An inspiring teacher sells good students on science and mathematics. All other activities may support the teacher—none may substitute for him. The members of the State Academies of Science, likewise, hold the key to success of individual teachers. In the District of Columbia and within a 25 mile radius the Washington Academy of Sciences has a scientist representative for every school. These scientists are meeting the problems and assisting teachers in many phases of teaching and guidance.

This may not be the best way to meet the Crisis in Science Education, or even a possible way in many areas, but the fact remains that greatly increased activity of scientists is essential to the satisfactory replacement of those who retire and necessary if we are to continue with our expanded needs for new scientists and teachers.

NEWS OF TENNESSEE SCIENCE

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Biology Division, Oak Ridge National Laboratory

Mary Esther Gaulden attended a committee meeting in Washington, January 13-15. The committee met to prepare the program for the Inter-American Conference on the Peaceful Uses of Atomic Energy to be held at Brookhaven National Laboratory, May 13-18, 1957.

Joan Wright Goodman has joined the Biology Division to carry out studies in the Mammalian Radiation Recovery Program with Dr. Congdon under a Public Health Service Research Fellowship. Dr. Goodman received the Ph.D. degree from the University of Rochester in Physiology.

Robert C. von Borstel presented a four-week series of lectures in January for the Radiation Science course in the Department of Biology, Florida State University, Tallahassee.

Dr. Alexander Hollaender presented two lectures at Duke University February 13 and 14. He spoke before the Zoology Seminar on "Studies on the Mechanism of Radiation Protection and Recovery and before the Cancer Training Program of the School of Medicine" Studies on Counteracting Radiation Effects on Mammals."

Miguel Mota of the Estacao Agronomica Nacional, Sacavem, Portugal, has arrived to work in the Biology Division for one year under an International Cooperation Administration fellowship awarded by the National Research Council. Dr. Mota, who is a cytogeneticist, is working in the Cytology and Genetics Section with Drew Schwartz.

Recent visitors at the Biology Division, Oak Ridge National Laboratory, include the following: Dr. Samuel Middleton, Chief, Professional Education Branch, Pan American Sanitary Bureau, World Health Organization, Washington; Dr. Arne Nelson, Research Institute of National Defense, Stockholm, Sweden; Dr. David W. H. Barnes, Radiological Research Unit, AERE, Harwell, England; Dr. R. R. Overman, University of Tennessee Medical School, Memphis; Dr. R. Scott Russell, Department of Agriculture, University of Oxford, England; Dr. J. W. Hollingsworth, Chief, Medical Service, Veterans Administration Hospital, West Haven, Connecticut.

The Health Physics Division of the Oak Ridge National Laboratory sponsored a symposium on Information Theory in Health Physics and Radiobiology, held in Gatlinburg, October 29-31.

Alexander Hollaender and W. L. Russell of the Biology Division, Oak Ridge National Laboratory, were in New York City in December to attend a meeting of the Committee on Genetic Effects of Atomic Radiation sponsored by the National Academy of Sciences, National Research Council. While in New York, Dr. Hollaender met with officials of the United Nations for official discussions.