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The Science Teacher Improvement Program of the AAAS

By HAROLD E. WISE

THE SITUATION

During recent years it has become increasingly apparent that even in the midst of an economic era which is plagued by surpluses of many commodities, the United States is experiencing a critical shortage of scientists and engineers with the training essential to our expanding technical civilization and to our national security. *Life* magazine for February, 1956, carried an article bearing the title, "Big Flesh Market for Physicists," which described the efforts of 300 companies and government agencies to fill orders for 2,000 skilled physicists. It was reported that only about 275 of the 4,000 attending the meetings were really interested in jobs. The Sunday issue of any large metropolitan newspaper may be expected to include several pages filled with advertisements for scientists and engineers to fill waiting jobs. The *New York Times* recently carried a full page article with a headline reading, "Engineer is 'King' as United States Industry Vies for Talent; Five Thousand Organizations Using Raiders and Recruiters to Fill 50,000 Jobs; Students are Courted; Salaries for Beginners Twice Those of a Decade Ago—Top Posts Go Begging."

It has been indicated by our most reliable sources that we now have about 800,000 to 1,000,000 scientists and engineers with our colleges and scientific schools turning out approximately 23,000 per year. It is estimated that we need at least twice this number per year in order to maintain our position of national leadership. Mr. Allen Dulles, Director of our Central Intelligence Agency, has stated that between 1950 and 1960 Russia may be expected to produce 1,200,000 scientists and engineers as compared to 900,000 in the United States.

Rear Admiral Strauss, Chairman of the United States Atomic Energy Commission, has predicted that if another war cannot be avoided, it will "almost certainly be lost by the country with the fewest resources in trained manpower." A somewhat similar outcome of a continuation of the "cold war" was recently predicted by a high Russian official when he said, "We don't have to fight. Let us have peaceful competition and we will show you where the truth lies Victory is ours."

How can the supply of scientific manpower be increased? It has been found that many young people make significant career decisions while in high school. It is, therefore, to the high schools rather than to the colleges and universities that we should look

for help. It should be a matter of national concern that somewhat less than half of those of our high school graduates who rank in the upper fifth in intelligence and potential ability go on to college. As a result of a national survey completed in 1955 at the request of the National Science Foundation, it has been estimated that "every year up to 200,000 18-year olds with college level ability are lost to higher education and presumably do not develop their talents to the fullest possible degree." This study also indicated that lack of motivation is a greater obstacle to college than is financial need.

How can some of this group of high school students be lead to investigate the possibilities of careers in the field of the pure or applied sciences? It seems that this might best be accomplished if these boys and girls can be enrolled in science and mathematics courses while they are in high school and if, as students in such courses, they can be taught by capable, inspiring teachers. Unfortunately, within the past three or four decades, there has been a definite slump in providing such opportunities in the high schools of the nation.

In proof of this statement, I will cite a few of the many statistics which support this conclusion.

1. The number of qualified teachers of science and mathematics has fallen off about 53 per cent in the past five years while the high school student body has increased 16 per cent and continues to go up.
2. A recent survey indicates that from 250,000 to 400,000 high school students in our country presently are learning mathematics from teachers not trained to teach it, and the same situation prevails in science teaching.
3. Government figures show that the number of part-time science teachers in our schools out-number full-time science teachers.
4. Fifty-three per cent of our high schools do not teach physics and one-half of them do not teach chemistry.
5. In the spring of 1955, only 249 men and women who had prepared to teach high school physics graduated from colleges and universities in the United States.
6. The number of science teachers needed in the schools will rise from 67,000 in 1952-53 to 84,000 in 1959-60 and 100,000 by 1965.

There is considerable evidence and a growing conviction among many who are interested in the development of our public high schools that the superior student is being neglected. This is unfortunate and results in a tragic loss to our society. Nationally, we spend large sums of money to develop our material resources; but we are only awakening to the necessity for the conservation

and development of one of our most vital instruments of progress and defense—the “gray matter” of our gifted students.

CONSTRUCTIVE EFFORTS

Within the past five years, several organizations and agencies have accepted the thesis that some of the more capable students may be led to prepare themselves for careers in science and engineering through the improvement of facilities for instruction in science and mathematics in our high schools. As a result, a number of projects and programs have been initiated with a view to helping solve the general problem of scarcity of scientific manpower. I will mention briefly a few of these projects before discussing the STIP program of the AAAS.

Under the leadership of Dr. Watson Davis, Science Service with headquarters in Washington D. C., has continued to provide helps for science teachers throughout the United States in the organization and direction of science clubs. This organization has directed the annual Westinghouse Science Talent Search which provides each year for 40 all-expense trips to a five-day Science Talent Institute in Washington D. C., as well as for a number of scholarships for study in leading colleges and universities. Science Service also cooperates with 27 states in State Science Talent Searches which are patterned after the national search. In addition, it cooperates with a number of local organizations in the promotion of science fairs.

Drawing its support from industry, the National Science Teachers Association through its Future Scientists of America Foundation, has provided fellowships to science teachers for summer conferences. With the cooperation of 25 universities, it has also provided summer research assistantships for a number of science teachers. This activity is to be expanded during the summer of 1956. In addition to these activities, the Foundation has conducted an achievement award program for science students, a recognition award program for science teachers, and has issued many booklets and reports of value to the science teacher.

American industry has been a staunch supporter of anything which seems to have possibilities for improving science instruction in high schools and colleges. Among other things industry has furnished several excellent career guidance booklets and films; it has furnished speakers and consultants for conferences; it has put up money for summer conferences of science teachers and through fellowship programs has offered to many science and mathematics teachers opportunities to spend a profitable summer in the study of the applications of science and mathematics in an industrial or research organization.

In April of 1955 the Division of Physical Sciences of the National Research Council and the American Institute of Physics joined in arranging a conference which was held at the Green-

brier Hotel in White Sulphur Springs, West Virginia. This conference of physicists, educators, and representatives of both government and industry resulted in a series of recommendations which are without doubt influencing several significant action programs today. For example, this conference and these recommendations may have helped to secure the inclusion in the requested budget for the National Science Foundation of an item asking the Congress for \$5,000,000 to help improve the teaching of science and mathematics at the high school level.

It is possible also that this conference may have served as one stimulating influence which has resulted in the introduction of a bill asking the Congress of the United States to amend the Smith-Hughes Act to include teachers of science and mathematics. This bill, S-3271, sponsored by Senators Kerr, McNamara, and Munroney, has been read twice without opposition and has been referred to committee.

One of the interesting results of the conference at White Sulphur Springs has been that it stimulated the initiation by the National Academy of Sciences of a Science Teacher Improvement Program in Arlington, Virginia. This pilot program, under the leadership of Dr. John Coleman of the National Academy, may easily set a pattern of what may be accomplished by interested groups in other communities. Among other things this project has revealed the fact that practically every teacher in Arlington who is head of a family must have supplementary employment to make ends meet. Jobs which have been reported include one of six nights a week as a short-order cook in an all-night diner. Certainly this program deserves the close attention of those of us who are interested in what can be done for teachers of science and mathematics.

The Sixth Institute of the Thomas Alva Edison Foundation was held in West Orange, New Jersey, in November, 1955. It is significant that the theme of this Institute was "The Improvement of the Quality of Science Teaching" and that major attention was given to the problems of science teaching in our high schools. During this meeting some of the nation's top scientists and engineers, including Lewis L. Strauss, Rear Admiral Rickover, John R. Dunning, and Charles F. Kettering, called attention to the seriousness of the growing shortage of scientists and engineers and suggested ways and means of alleviating the situation.

Other endeavors deserving of mention include programs subsidized by the National Science Foundation which are to be launched at Oklahoma A. & M. College and at the University of Wisconsin next September. In the Wisconsin program fifty high school science and mathematics teachers will be brought in to work in a program leading to a special degree, Master in Science

Education. Courses leading to this degree, which will be taught by staff members of the respective science departments, have been organized in an attempt to meet the specific needs of high school science teachers. Each teacher selected for the program will receive a base stipend of \$3,000 with an additional \$300 for each dependent. The University of Wisconsin will receive \$200,000 for its contribution to the project.

THE AAAS PROGRAM

The Cooperative Committee of the American Association for the Advancement of Sciences was organized in 1941 to work on problems of science and mathematics teaching which are the common concern of the many professional organizations of scientists and mathematicians. Currently, there are approximately eighteen members of the Committee each representing a major professional organization or (in a few cases) a national organization primarily interested in the teaching of mathematics or the sciences. There is also one representative of the Board of Directors of AAAS. During the years since its beginning, this committee has made worthy contributions including a report on "The Present Effectiveness of our Schools in the Training of Scientists," which in 1947 became a significant part of the Steelman Report to the President of the United States.

About two years ago members of the Cooperative Committee and two representatives of the Academy Conference decided to try to set up a program looking toward the improvement of the quality of science instruction in our high schools, as well as to increasing the supply of well trained teachers of science and mathematics. The resulting seven-point program of the AAAS was submitted to the Carnegie Corporation by Dael Wolfe, Executive Officer of the Association. The corporation approved a grant of \$300,000 to help finance the effort. In September, 1955, Dr. John Mayor assumed his duties as Director of the Science Teaching Improvement Program (which, in true Washington tradition, has been shortened to the STIP program.) On the 25th of January, 1956, Dr. Irvin E. Wallen of Oklahoma A. and M. joined Dr. Mayor as Assistant Director.

It must be emphasized that the AAAS does not expect its program to solve all of our problems. It does hope that the STIP program will help in the current situation. Specifically, it is hoped to make worthy contributions through seven programs or types of efforts as follows.

Responsibility of Scientists

First, it is believed that scientists themselves should assume greater responsibility for helping to direct the preparation of those who will teach mathematics and the sciences in our high schools. Probably no one will question that a high school science teacher must have "reasonable knowledge" of his subject. Also, it is gen-

erally conceded that such a teacher should have a "reasonable knowledge" in the field of teaching. It is in the defining of what constitutes "reasonable knowledge" that the difficulty lies. State departments of education and accrediting agencies may usually be depended upon to see to it that the teacher has met formal requirements in education. However, there does not seem to be a comparable effort to insist upon uniform and adequate preparation in subject matter. *Time* magazine for February 27, 1956, carries an interesting item under the heading, "Why Johnny Hates His Math." In this article it is indicated that as a result of a survey made by Educational Testing Service of Princeton, it has been found that "although all states require education courses for secondary mathematics teachers, a third of the states require no mathematics for certification of mathematics teachers." It is believed that scientists can and should accept greater responsibility and exert greater influence not only in defining adequate preparation in the subject to be taught but in helping to bring about ways and means of insisting that the beginning teacher has such preparation.

It is believed also that scientists may be influenced to contribute to the solution of the problem by making it a point to encourage more students with the necessary aptitudes and interests to prepare for teaching careers both at high school and college levels.

In recognition of the fact that many persons now teaching high school science and mathematics are not well prepared in subject matter, it is believed that additional colleges and universities may find it possible to develop courses suitable for high school teachers who return to the campus for study during the summer. The difficulty here is that a teacher almost invariably wants and needs graduate work to satisfy requirements for continued certification. Unfortunately, few teachers are prepared to carry graduate courses in any field but in education. Turned away by science departments, they therefore major in education and an opportunity for the improvement of science teaching is lost.

Several alternatives suggest themselves. First, the certification laws might be changed to read "post graduate" rather than "graduate." However, it is possible that in many states such a change, if suggested, might be opposed by the same groups which originally promoted the requirement of "graduate" work for certification purposes. Second, the college must face the dilemma of sacrificing standards in advanced science courses or of giving graduate credit for courses which are essentially undergraduate. Some colleges and universities have met this dilemma by organizing special summer courses for science teachers which carry graduate credit in education, even though they are planned and taught in science departments. In other schools such courses carry graduate credit

in a science field only for those persons who are majoring in education.

Science departments in colleges and universities may be of direct assistance in interesting greater numbers of high school students in scientific careers through providing consultant and lecture services to high schools. The AAAS program hopes to stimulate greater interest in this type of activity.

Two departments of the University of Nebraska, Bacteriology and Physics, have utilized successfully this method of stimulating the interest of high school students during the past two years. Representatives of these departments, who are for the most part among the younger members of our faculty, are very optimistic as to the results of their efforts.

Emergency Measures

The second type of effort envisioned by the STIP program will be directed toward the better utilization of those potential resources for science and mathematics teaching represented by individuals who have had the necessary preparation in subject matter but who lack the required courses in education. Such persons are to be found among seniors in liberal arts colleges and also among recent graduates of liberal arts colleges. It is believed that institutions of higher education should take the initiative in setting up accelerated programs in professional education for these persons. The AAAS plans to study what has been done in this direction and to hold a series of state conferences of scientists, educators, and state certifying officials to stimulate additional efforts in the development of such accelerated programs.

Recruitment

The third objective of the present Association program is concerned with the recruitment of potentially qualified students to prepare for teaching careers. In recognition of the fact that any successful program of recruitment must be based upon knowledge of what people find attractive and unattractive in a field, STIP plans to make a study of these factors. The findings of such a study may then be used to suggested specific changes in school policies and practices to make teaching more attractive and to increase its holding power. It is the personal opinion of your speaker that this study will show that low salaries are at the root of much of the difficulty in attracting and holding competent science and mathematics teachers. The problem of securing higher salaries has been recognized as a fourth objective of the STIP program.

Higher Salaries

Obviously, the AAAS is in no unique position to influence the raising of teachers' salaries. It can only cooperate with other interested agencies to stimulate widespread local action to increase salaries. To this end, it hopes to enlist the aid of state academies

of science in bringing before the public the need for higher salaries for all teachers and the special problems that exist in the fields of science and mathematics.

In planning the STIP program, a majority of members of the Cooperative Committee felt that salaries of science and mathematics teachers probably could not be raised above general levels. This is not the opinion held by your present speaker. I believe that a satisfactory solution to the problems created by a shortage of adequately prepared science and mathematics teachers will be reached only when qualified teachers can be employed on a twelve-month basis at salaries which are approximately the equivalent of those paid in professions requiring comparable ability and preparation. If this means a break away from the single-salary schedule whereby the salary of a teacher is determined by the level of formal preparation and years of service without regard to field of study or merit, then, I believe such a break is justified in the interest of national welfare. After all, we usually manage to pay our coaches at a rate above the general level.

Better Working Conditions

It is probable that better working conditions, including lighter teaching loads, more adequate laboratory facilities and instructional equipment, and less demands on time for extra-curricular activities, would not only help hold teachers in their positions but also might act to attract more competent persons into teaching. The fifth objective of the STIP program will, therefore, be to investigate the effectiveness of the use of teaching assistants and all kinds of instructional aids in increasing teaching efficiency. The AAAS also plans to seek ways and means of encouraging high school teachers to attend scientific meetings and to give support to the provision of time off and reimbursement of travel expenses to encourage this attendance.

Awards for Distinguished Teachers

"Intelligently administered, rank and honor are not only an award to those who receive them but an inspiration to those who aspire to them." This principle has been quoted from the Association program as presented to the Carnegie Corporation. The principle served as the basis for the sixth phase of the STIP program; i. e., the suggestion that approximately 100 outstanding science teachers be honored each year by being designated as Distinguished Service Teachers. It was the feeling of the planning committee that, if financial backing could be secured, each citation as a Distinguished Service Teacher might be accompanied by underwriting expenses for attendance at the annual meeting of the AAAS.

The Carnegie Corporation specified when approving its grant that no part of the funds were to be used for this section of the

proposed program. However, other sources have indicated specific interest in this proposal and the needed financial assistance may be secured very soon.

Consultants to Teachers

Even if efforts to retain experienced science teachers in the classroom and to increase the number of young people who prepare to teach science are very successful, the steadily increasing enrollment expected within the next few years will in all probability necessitate the employment of many science teachers with less than adequate preparation. The seventh and final phase of the STIP program was planned as a series of "pilot studies" to see if making a qualified person available to help a limited number of such teachers would tend to "up grade" the quality of their instruction. It was assumed that a teaching counselor or consultant operating entirely without administrative authority could tutor, assist, and serve as a source of information to the less-experienced and probably less-competent science teachers of a limited region. If it be assumed that one consultant could be made available to a group of 25 to 50 teachers, the total increase in staff would amount to only two to four per cent. It is possible that the total effectiveness of instruction might be greater under this plan than if the additional individuals simply taught classes all day. Four centers have been established to test this hypothesis during the next two years beginning in September, 1956. Responsibility for administering the work of these centers has been delegated to four state universities: Pennsylvania State University, the University of Oregon, the University of Texas, and the University of Nebraska. Each of these centers has been allocated a budget of \$19,000 per year to cover partial expenses of this program.

Two or three counselors, each an experienced teacher of proven ability with training at least equivalent to the Master's Degree in a science or in mathematics, will work out of each center. In working with science and mathematics teachers in their respective areas, these counselors will seek to:

1. Make a study of laboratory and library facilities in cooperating schools and suggest improvements as needed.
2. Examine the counseling process as it operates in each school to determine if it can be made more effective with respect to science and mathematics.
3. Review the subject offerings in science and in mathematics and make constructive suggestions for improving the programs as needed.
4. Review the prerequisite skills pupils in science and mathematics bring to their classes and make constructive suggestions when needed.
5. Evaluate teaching procedures and suggest improvements as needed.

6. Strengthen the cooperation between high school science and mathematics teachers and the corresponding faculty members of the cooperating university.
7. Plan for the improvement of subject matter and teaching competency on the part of the instructors through additional post-graduate or graduate work at the cooperating universities or elsewhere.
8. In general, perform according to their best judgment the many functions which may be possible in the different schools of their territory to improve instruction in the sciences and in mathematics.

At the University of Nebraska, we are of the opinion that the success or failure of this program will depend in no small measure on the natural ability of the consultants to work with people and upon their capacity for leadership. One of the biggest problems, therefore, is that of finding two persons with the necessary experience and academic training and with those qualities of personality which will seem to guarantee the success of the project.

We have provided for administration by the appointment of a director who will give approximately one-fourth of his time to the project. This director will act as chairman of an administrative committee of six members made up as follows: the Director of the University Extension Division, the Deputy State Commissioner of Education, the Assistant Dean of the Graduate College, and one representative each of the Departments of the Physical Sciences, the Departments of the Biological Sciences, and the Department of Mathematics. A much larger advisory committee will meet from time to time to discuss the progress of the project. This committee includes the Director of the project, members of the administrative committee, and, in addition, the Dean, the Chairman of the Department of Secondary Education, the Director of Teacher Training, and the Supervisors of Mathematics and of the Sciences from the Teachers College. It includes also the Dean and the Chairman of the Departments of Botany, Zoology, Physiology, Bacteriology, Geology, Physics, Chemistry, and Mathematics of the College of Arts and Sciences.

At the University of Nebraska we hope, after two years, to be able to show results from this project which will encourage state agencies to continue to provide consultant services in science and mathematics as long as inadequacies in the preparation of our teachers makes such services desirable.

In conclusion, I wish to emphasize that the AAAS and other interested organizations cannot hope to achieve any large measure of success in improving the instruction in the high school sciences and in mathematics and in increasing the available supply of able scientists without the cooperation and concurrent efforts of many other groups and organizations. It is hoped that these supporting

efforts will be many and that through concerted action our source of scientific manpower may not be permitted to dry up at the roots.

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