NSF: New Study on Science, Math Teachers in High Schools Focuses on Their Education, Assignment

In the half dozen years since the first Sputnik made American schools an even hotter national issue than usual, no sector of learning has received more attention than science and mathematics education in the high schools.

A good deal has been done in recent years in the way of curriculum reform, technical innovation, and public promotion of the mystique of science, but the truism that the teacher makes or breaks science and mathematics education still holds, and the National Science Foundation has just published a report which sheds some light on the key questions of how well these teachers are prepared and how they are used.

This report, *Secondary School Science and Mathematics Teachers, Characteristics and Service Loads* (for sale by the Superintendent of Documents, Government Printing Office, Washington, D.C., 35¢) makes no startling revelations but solidly documents problems about which every teacher and administrator knows.

It is no news that teacher shortages and other shortcomings afflict education in science and mathematics in secondary schools, but what the report makes clear is that not only are there deficiencies in the education of teachers of math and science now in the schools but that the teacher assignment pattern aggravates the problem. Here are some of the salient findings of the survey.

1) It is the lucky physics or chemistry teacher who can specialize in one field; 81 percent of the physics teachers and 68 percent of the chemistry teachers covered in the survey taught only one or two courses in their subject.

2) If 18 undergraduate semester hours in a subject are considered adequate minimum preparation for teaching a scientific subject, then 34 percent of the classes in chemistry and 66 percent of the classes in physics are taught by inadequately prepared teachers.

3) Although 75 percent of the teachers in the survey reported having done graduate work of some kind, less than 40 percent indicated that the work was in the subjects they were teaching.

The survey does show that mathematics and biology teachers are somewhat better prepared in their subjects, in terms of both undergraduate and graduate courses, and likelier to be full-time teachers in their subjects than their colleagues in chemistry and physics.

The report does not attempt a detailed analysis of the reasons, but the underemployment of physics and chemistry teachers in their fields is partly the result of the demand factors built into the high school curriculum. Chemistry and physics are normally restricted to one-year courses, and the enrollment figures show that a minority of the students take these electives.

The demand for mathematics and biology teachers is generally greater, since math is a required subject in junior high school and the early high school years and biology seems to be a more popular subject than physics or chemistry, primarily, it seems, because it is deemed the easiest. Biology also appears, in practice, to dominate the general science courses; these are the most heavily patronized of the science courses and are often taught by teachers with some preparation in biology.

About Quality

Because the survey concentrates on such quantitative factors as age, sex, teaching experience, and academic credits, it naturally provides no direct comment on such things as the quality of teacher preparation or teaching standards. In dealing strictly with matters of fact, however, the survey provides an extremely useful body of data, not previously available, on the condition of science and math teaching in the high schools.

The study was carried out for NSF by the American Association for the Advancement of Science (AAAS) and the National Association of State Directors of Teacher Education and Certification (NASDTEC), as the latest foundation study on scientific manpower.

Through this study of the professional background and "service load" of representative teachers in grades 7 through 12, NSF expected to obtain data useful in designing summer institutes and other teacher training programs NSF itself sponsors, and also to provide guidance for others developing academic programs for prospective teachers.

A random sample of 3597 teachers active in the 1960–61 school year was taken from a register compiled by the National Science Teachers Association, and 3012 usable questionnaires were returned; about 90 percent of these came from teachers in public schools, 10 percent from teachers in private schools.

Of this 3012, 1280 taught one or more classes in mathematics but none in science, 1230 taught one or more classes in science but none in math, and 502 taught both math and science.

All 50 states are represented. For the purpose of making regional comparisons, the returns were separated into four regional groupings—Northeast, South, North Central, and West.

The regional breakdown showed that in the North Central area, covering the Midwestern states, a quarter of the teachers—a larger proportion than in any other region—taught in schools with enrollments of less than 300. Nationally, 18 percent of the teachers taught in schools with enrollments under 300, while almost a third of the teachers in the survey taught in schools with fewer than 500 students.

The serious problem for small schools of providing adequate science and mathematics instruction has been given special attention by many, including James Conant, who, in his report on the American high school, laid special stress on the limitations of high schools with fewer than 100 graduates per year.

In small schools, the small size of the classes in math and science, particularly in electives, make such courses uneconomic. Administrators complain of difficulties in recruiting qualified math and science teachers willing to fill out their schedules with subjects other than their specialties. In practice, administrators often deal with these problems by assigning unqualified teachers to math and science classes, or by not scheduling them at all.

Regional differences revealed in the study were, in most respects, not striking, but in regard to salary and graduate study, there appear to be noteworthy variations.

At the low end of the scale, some 40 percent of the teachers in the South reported salaries under $4000, with the median annual salary for the region falling below $4500. Teachers in Western states were generally the best paid, with the median for the region above $5500.

The highest proportion of advanced

degrees—46 percent—was reported by teachers from the Northeastern states, while teachers in the South reported the lowest proportion—32 percent.

One interesting finding was that a substantial majority of the teachers of science and mathematics in secondary schools are men. "Men predominate among these high school teachers," says the report, "particularly in the subjects other than mathematics. Of the entire sample, 69 percent were men. Of the teachers who taught mathematics but no other science, 63 percent were men. Of those who taught sciences other than mathematics, 75 percent were men. The ratio of men to women was lowest in the South (59 percent), highest in the West (78 percent)."

This preponderance of men appears to be a natural consequence of the disinclination, which Conant noted and lamented, on the part of able girls in high school to study chemistry, physics, or the more difficult forms of mathematics.

In the conclusions of the survey, two points are stressed: (i) the limitations on opportunities for full-time science teaching, and (ii) the inadequate preparation, in terms of formal course work, of many science and math teachers.

Applying the "guidelines" set up by NASDTEC-AAAS recommendations on the preparation of secondary school science and mathematics teachers [*Science* **131**, 1024 (1960)], the report had this to say about teacher education.

"It would be ideal to have every high school science class taught by a teacher who has a substantial education in the subject and who can keep his knowledge reasonably up to date. Any estimate of how far the nation's high schools are from this goal must depend upon somewhat arbitrary standards of measurement; but it seems moderate enough to say that a teacher who has less than 18 semester hours of college work in a science does not have a substantial education in it, and we have seen that two-thirds of the physics classes, a third of the chemistry classes and more than a fifth of the biology classes and the upper-level mathematics classes are taught by such teachers. Many physics classes, and in fact large numbers (if small percentages) of the classes in every high school subject are taught by teachers who have had only a single 1-year college course in the subject—or even none at all."

What the NSF study cannot show is how well, rather than how much, these teachers have been trained and how good or bad their performances are. And a demand for improved teaching in science and math has come from the critics of the schools and from the public, who have grasped the idea of competition with the Soviet Union in science and technology.

Professional educators are certainly aware of this demand, but they face other demands as well, and it is fair to say that their major response has been indirect—that is, to rely on general efforts to raise teacher certification standards and to strengthen programs for teacher education and thereby improve teaching generally.

The main movement in teacher education in the past generation has been toward the requirement of 4 years of college for both elementary and secondary school teachers, and recently a year of graduate study has been added as a requisite for "professional" standing.

This movement had an expansionary, some say inflationary, effect on institutions where teachers were educated. Normal schools grew into state colleges, and these later instituted graduate programs, at least in education. During this growth period, education students came to take a substantial portion of their work in courses in teaching methods and other professional education subjects, a portion that critics of teacher training regard as excessive.

Many institutions emphasizing teacher training did not develop strong departments in mathematics and the natural sciences, and students preparing to teach science and mathematics often took denatured courses—for example, how to teach physics, rather than physics itself.

Certification a Weapon

The most effective of the instruments employed to bring about the leveling up in the education of teachers has been the teacher certification authority, which is centralized in the state departments of education. This certification power has grown as state payments of funds for education to local school districts have been linked to salary schedules based on certification levels. In this way, approved academic achievement —notably, credits in education courses —became, along with longevity, a determinant of salary. In the same way, graduate study, in the eyes of some, became less a way to gain learning than a means of winning the next pay increment.

Certainly, stout efforts are being made, in teacher education, to resolve the "methodology versus content" conflict and to give better preparation to future teachers of science and math, but the main emphasis in teacher preparation appears still to be on the battle to eliminate or upgrade the "unqualified" and "substandard" teachers, to certify the teacher and accredit the teacher-education program.

It is probably true that many teachers who qualify on paper are not satisfactorily prepared to teach in these fast-moving fields. On the other hand, the person with solid college training in science or math may be discouraged from teaching because of certification requirements.

Whether the machinery of accreditation has created special problems in science and math teaching, however, is an open question. But if secondary schools are the seedbeds of scientists, mathematicians, and engineers, as is generally assumed, then this is one of a number of important questions which the useful NSF study makes only a start at answering.—JOHN WALSH

House Armed Services Committee Forms R&D Subcommittee to Oversee Rising Research Funds

Further evidence that Congress is serious about looking over federally supported research activities that it overlooked before is to be found in the appearance of a new House Armed Services subcommittee on research and development.

House Armed Services is the authorizing committee for the nation's $50 billion-plus annual military program, and the R&D portion of the defense budget has been climbing and this year amounts to an estimated $7 billion.

Armed Services Committee chairman Carl Vinson (D.-Ga.) is said to have felt that military R&D expenditures simply had reached a level that made a separate subcommittee necessary; he named as chairman Congressman Melvin Price (D.-Ill.), who reportedly has been interested in the post since the possibility of an R&D panel came up a year or two ago.

Price is a member of the Joint Committee on Atomic Energy and heads the JCAE subcommittee on research, development, and radiation, which