PRESIDENTIAL ADDRESS

WHERE ARE WE HEADED?

HOWARD W. GOULD

Northern Illinois University, DeKalb

As I stand at the end of my teaching career of some 45 years, I feel that some personal opinions and general impressions of educational trends and problems in science teaching may be of more interest and value to the Academy than the description of a specific line of research. In view of curricular changes, the present overcrowding of schools and the recognized importance of education in America, I doubt if there will ever be a more appropriate time to do this.

In the last decade, college enrollments have grown from about two millions to about 4.5 millions, with about seven millions predicted for 1970. This, of course, is due to population increase which reached a peak in accelerated growth about 18 years ago, also due to the fact that the proportion of high school graduates who enter college is increasing to a present value of about 30%. Most of this increase will be assumed by the public colleges and universities and junior colleges, rather than by the private schools who will continue to pick and limit their enrollments.

In America we have sought 12 years of education as being the right of everyone who is capable of it and wants it. Now public opinion tends to extend this to 14 years, or to include two years of additional training beyond high school. Professions which once called for high school diplomas now call for college training and specialization beyond. The limit to what the people want and will pay for remains yet to be seen.

Now science is involved in this growth, along with all the other disciplines, since it is now included in the educational curriculum as contributing to the culture and satisfactory life of the educated person. More recently when the Russians startled us with their first satellite, Sputnik, everyone suddenly became interested in comparing our educational system with that of the Soviets. The implication was that we should expect our children to learn more of everything, and more science in particular.

How much science do we require of all our students in American colleges? Well, a recent survey of 65 selected schools reveals that two to four semesters of science are usually prescribed under general education. Such requirements fall under two general choices: (1) selection of one or more laboratory courses in the sciences which are also taken by majors and minors, and (2) special abbreviated or cross-disciplinary sequences which are more or less integrated and terminal in treatment.

These courses are under continuous scrutiny and revision. With apology to the biological sciences, I shall indicate trends chiefly in the physical sciences with which I am identified by direct experience.

Chemistry and physics have been taught both separately and as combined physical science with and without inclusions of illustrative material from geology and astronomy. The emphasis has shifted from a survey of many topics to the selection of a few, then to a few basic principles with applications from selected elements and areas. In some cases, all the sciences and mathematics have been included in a more or less integrated sequence and presented by several instructors. My experience with such courses leads to the belief that a minimum of eight semester hours should be devoted to a physical science combination if a fair acquaintance with the area is to be attained. There is increasing favor toward such a sequence rather than abbreviated separate courses in chemistry and physics. But lack of interest or fear or loss of students by a single department explains the slow change.

The manner in which such courses are offered varies along the lines of lecture and laboratory sections, or lecture-demonstration and visual aids with optional laboratory or without it. More recently, closed-circuit television has been used for large numbers of students in different rooms. The success of this last innovation depends heavily on the care and skill with which the lecturer makes his presentations. The requirements are of a high order, comparable to those for a successful sound movie program, like the Baxter series in chemistry or the White series in physics. Attempts to measure the relative efficiency of different methods of presentation indicate that the method used is less significant than the skill of the instructor and his success as compared to that of other instructors.

I refer now to courses for physics and chemistry which are set up for majors and those in related fields. The content, scope, and treatment of these also have been undergoing change. In high school, the original intent was college preparation. Since most students then did not go on to college, more practical terminal courses were devised. And now, more recently, the prevalent idea is not to include any number of topics but to emphasize general properties, energy change, and atomic and molecular structure, as in the PSSC program in physics, and the CHEM study and the chemical bond approach (CBA) in chemistry. In college, introductory chemistry and physics likewise have been undergoing extensive change. General physics has comprised anywhere from one to two years of time, involving the use of varying amounts of calculus, with more time spent on atomic physics and less regard for covering all areas such as acoustics or fluids. General chemistry now emphasizes atomic structure and the nature of chemical bonding, energy and chemical equilibria, and colligative properties of solutions. The laboratory work includes more quantitative experiments and increased use of modern instrumentation. In short, it includes much material which once was confined to courses in physical

chemistry, quantitative analysis, and atomic physics. All this is by way of adjustment to what has been going on in high school chemistry and in advanced college courses.

Opportunity is now provided for high school graduates of exceptional ability or training to elect honor sections in college, or to by pass one or two semesters of introductory courses by proficiency examinations. Incidentally, college entrance requirements are gradually being raised in the public institutions as well as in private schools. So that those in the lower half or so of the high school diploma graduates must pass entrance tests to be eligible for admission. Reasonable standards of reading, writing, and speaking ability are more and more required for college entrance. The responsibility for correcting deficiencies in these respects is left to the elementary and secondary levels. There is also the fair certainty that more equal educational opportunity for minority groups will soon be effected, as for the Negro in the southern states, so that the success of these in college will be more likely. Post graduate high school work, trade schools, and junior colleges are already coming to be likely places for successful work immediately beyond high school graduation.

The increase in college enrollment calls for teachers to be trained for it. An earned Ph.D. is practically a prerequisite for upper rank college teaching. The number of institutions offering the Ph.D. has increased markedly in the last 40 years, and the number of degrees per year has increased from about 8000 in 1925 to about 25,000 now. The rate of increase in recent years is more sharply upward. Of this total, roughly about one-fifth are in the physical sciences. But, considering that many go into industrial research work, there are fewer available for college teaching positions — particularly in physics and mathematics.

May I now comment on a few aspects which I think need improvement. Ph.D.s in college teaching are frequently in an atmosphere where the emphasis is solely on scholarly research. This is particularly true in growing institutions where graduate programs are just getting under way. Promotions in salary and rank are too often based primarily on productive scholarship as evidenced by the number of publications. Those interested in teaching are in danger of being by-passed, no matter how good they are, unless they are also productive scholars to the extent of adding to the flood of routine and often mediocre scientific literature.

One of the principal functions, if not the chief one, of a university is teaching. By teaching, I mean any and all ways in which information is imparted. It is personally delivered by the staff in lecture, quiz, seminar, laboratory, and individual conference. In the mind of the student, any school is good or bad chiefly in terms of the atmosphere he experiences from his professors and staff in general. I do not mean to imply that more attention should be given to teaching at the expense of research. Actually the two are complimentary. Teaching is strengthened by research. And there is no substitute for thorough grounding in a discipline. It is just that any Ph.D. who expects to work in an

educational institution should include teaching assistantship work in his training program. Excellence in teaching should be rewarded on a par with excellence in technical research ability.

Relative to the teaching function in a growing institution, there is the pressure to keep down per capita cost of instruction in various ways. Among these devices are the giant-size lecture sections, and the use of as few quiz and problem sessions as possible and supervised by junior staff or graduate assistants. This means less personal contact between the student and the senior staff. This system, although not as ideal as that in a smaller school, is not too bad if the junior staff is competently supervised and coached in teaching procedure. A graduate assistant should not be compelled to choose between doing a good job at his research and preparing for his degree examinations on the one hand, and teaching and counselling his students on the other. All too frequently he cannot do both successfully. I am disturbed by the report at Northern that there is an increasing number of transfer students to and from other schools. One explanation for this, presumably, is an unfriendly or unsympathetic teaching atmosphere.

Members of the Academy have been concerned about the lack of science background of many high school science teachers, particularly those teaching chemistry and physics. Much progress has been made to correct this in Illinois in recent years, due to consolidation and to raised standards. I want to call attention here to elementary education. The State course calls for science throughout the elementary grades. But the extent to which a good science program can be implemented depends on the science backgrounds of the teachers. In my opinion, the elementary education major has too little opportunity to acquire an adequate science background in the usual elementary curriculum which is heavily loaded with professional courses. While I do not disparage methodology, I do insist that there is no substitute for grounding in an area, be it narrow or broad. A scholar with no grasp of how to deal with youngsters and how to put his subject matter across to them makes a poor teacher. But he is not so misleading and pathetic as one who knows all about how to teach but has nothing to teach. A reasonable balance of the two is in order. In Illinois, the responsibility for curriculum improvement centers primarily at schools of education in the State colleges. For the Office of the Superintendent of Public Instruction now accepts for teacher certification the curricula set up by the schools whose business it is to train teachers. Those trained elsewhere must satisfy the requirements set up by the State Office.

There is general concern about implementing curricular change. In smaller institutions, this is handled by faculty committees working with the dean or president. In larger ones, direct faculty participation becomes unwieldy, and it is difficult or impossible to arrive at any consensus. Consequently, the major portion of the task falls to general councils, senates, deans, and upper cabinets in a university hierarchy.

Vested interests and log-rolling tactics are omnipresent, which means that administrators must assume more and more responsibility for seeing to it that curricular and course development keep fairly consistent with expert and general opinion. This calls for well grounded disciplinary training and due regard for democratic procedure on the part of the administration.

Another problem relates to the facilities used in instruction. Rapid expansion calls for systematic long-time planning. Assuming that the necessary capital is forthcoming, about four years is needed to analyze needs, plan, design, construct, and to equip a major building and move into it. Frequent change of program calls for construction of inner partitions and layout of facilities to permit readaption to new uses at minimum expense.

In the matter of mass instruction in large sections referred to above, lecture demonstrations are more needed, particularly where individual laboratory work is optional or omitted entirely. There is usually a shortage of class and lecture room space on the campus, so most large lecture rooms where demonstrations are held are used by other classes most of the scheduled hours of the day and night. Facilities, therefore, must provide for the setting up of equipment and materials on portable desks which can shuttle back and forth between service and lecture. Visual aid equipment should be, so far as possible, readily operable by the instructor without the aid of assistants. "Foreign" instructors and students should not tamper with equipment left set up for use by another instructor. Each should be alert to the needs of others also using the room. All this is not easy, and far from ideal for the demonstrator. But his painstaking work adds immeasurably to the value of the course for the students. As I look back on my own training, I realize that some of the best instruction I experienced was due to well-organized and demonstrated lectures. The excellent work of Richard Sutton in physics and of Hubert Alyea in chemistry, along with that of many others, is noteworthy in this connection. May such as they not become extinct.

The testing program used in these mass education sections also has problems. Objective forms of tests have largely replaced those of the essay type, due to lack of time and staff. Certainly, one important factor in good instruction is the quality and dependability of the tests used. Much is needed for the construction of a standardized test which is fairly free from ambiguous statements. There is also the problem of minimizing opportunity for student cheating. Over all the testing there hangs the question, what am I trying to measure, and how well am I doing it?

These are some of the educational problems that I have been engaged in and which I think are significant and important. If I were just now starting in again, I am sure that I would find more and better challenges than I found 45 years ago. I believe that we are just really getting started in this business of learning.

Presented April 23, 1965.