

PRESIDENTIAL ADDRESS

Graduate Degrees for College Science Teachers

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Some years ago the late Will Rogers was being escorted through Davis Gardens at Terre Haute. What met his eye was a vast acreage under glass devoted to the culture of "bigger and better" cucumbers. Will rubbed his chin in the characteristic manner and said, "Gosh! I never knew anyone ever tried to grow those things on purpose". If we are to put any credence upon the opinion of educators in general and upon the comments of college students by and large we might be forced to the conclusion that college instructors "just happen", and that too many of them make little pretence of being good teachers. As a matter of fact, the able scientist might feel that if he were known as a good science teacher, some doubt might be cast upon his ability as a researcher.

During the past year an interesting sidelight bearing on this situation was brought to my attention. A young man graduate from one of our smaller colleges was being interviewed by the head of a Science Department in one of our leading state universities. This young man had been recommended for a graduate assistantship in the department. After looking over the young man's credentials and asking him a few questions, the department head said, "Well, I don't think you have the ability nor the background which would make it possible for you to pursue graduate work successfully in the department, but we do need some extra instructors for our Freshman Classes. I'll recommend your appointment, but go easy on the graduate work". If this is a sample of the type of instruction being handed out to our science freshmen in the universities, maybe it is time for scientists to do something about it.

It might be worthwhile at this time to attempt to find out what the future needs will be for well-trained science teachers on the college level. We all know of course that our colleges and universities are overflowing with students, with thousands turned away for lack of facilities. Many of us last year thought this was a mere temporary affair which would vanish as soon as the G.I.'s had a sample of the rigors of higher education, but of course we all know now that such was not the case. The ex-service men liked the sample and cried for more. This fall, enrollments are higher than ever and the ex-service men who couldn't get in last year are taking over the places vacated by the few who had enough last year. Yes, more people are going to college than ever before and the trend is still upward. In 1940 there were approximately one million five hundred thousand students enrolled in colleges and universities in the United States. In 1930 there were approximately one million, while in 1920 there were about six hundred thousand. In 1946, there were well over two million and by 1950 most conservative estimates put the figure at nearly three million.

Another factor which will tend to increase future college enrollment is the increasing number of high school graduates. Just before we entered the war in 1941, seventy three per cent of the young people of high school age were actually enrolled in high school classes. The number fell off in the upper two years of high school during the war period, but now that the war is over the upward trend is here again. More and more young people are graduating from high school and conservative estimates set the figure at eighty per cent by 1950. There is no reason to doubt that an increasing number of high school graduates will enter college in the years to come if the colleges and universities can offer attractive opportunities for further study. Parents and young people as well realize that education for a profession offers the best guarantee of future dividends.

Science departments all over the country are feeling the impact of this upsurge in a manner which is not surprising. Most of the phenomenal increase has been in men students; and men students by and large are more likely than women students to elect science courses. In addition to this the war was widely advertized as a scientific war. The public in general realizes that we are living in a scientific age. The radio, the press, and even the pulpit are whooping it up for science until the scientist himself is having a difficult time trying to ward off idolatry. If ever there was a time for intelligent and purposeful instruction in the sciences, now is that time.

That there is a very definite shortage of well-trained and competent teachers in all schools from the kindergarten through the university no one will deny. The shortage in the colleges is especially acute in the sciences and mathematics. Everyone knows that a major part of the instruction given to our university freshmen in the sciences is carried out by young graduate assistants who do this work rather reluctantly as a means of supporting themselves in their principal work, scientific research. About the only acquaintance that a young science student ever has with a real science professor in the University is in the occasional lecture which he attends along with several hundred or perhaps a thousand other freshman. The real instruction comes when he meets with a smaller section under the guidance of a young instructor or graduate assistant. In my opinion, the average lecture attended by several hundred college freshmen falls far short of meeting the requirements for good instruction. It is true of course that the universities are replete with big name scientists, men who know what there is to know about science, but I am afraid the average freshman in physics, chemistry and biology rarely comes in contact with them.

That there is a definite shortage of instructors in the colleges and especially in the sciences one can see in a minute by comparing student-teacher ratios before the war and now. Before the war, the national average for all colleges was ten to one. This figure was accepted for forty years as fair and workable. Now the figure is nearly twenty to one. Added to this we must remember that the quality of instruction has deteriorated due to a shortage of well equipped teachers. If we consider the ten to one ratio desirable for efficient instruction, it is

conservatively estimated that we will need about 90,000 new full time college instructors by 1950. It goes without saying, of course, that the natural sciences will need their full share, probably one-fifth of this number.

Before the war, in the decade 1930-40 approximately 34,000 university doctorates were granted, about 3400 per year. Of these somewhat less than half that number, about forty per cent entered teaching as a profession. We are now some ten thousand staff members short, not to mention the positions occupied by instructors and graduate assistants who are poorly trained and should be replaced. This shortage is certain to grow.

Our experiences in the war have made it clear that we may have to rethink our philosophies of Education. Many college graduates and thousands of high school graduates have secured diplomas and degrees in the past without touching upon some of the vital areas of human knowledge. Thousands of college graduates in the past have never looked through a microscope nor have they had anything but a passing glimpse of scientific method. The Harvard report, the Princeton report, the Yale report and many others all point to the same conclusion. If we expect higher education really to do anything vital for the great masses of young people who are seeking college degrees, we must do something about general education. A vital part of general education must needs be concerned with science education, the scientific method and the contributions of natural science to human well being. We are going to need a competent staff of well trained, versatile science instructors for this task. The physics instructor will need to know something about chemistry, biology, geology, astronomy to say nothing of psychology and sociology. The atom is no longer the sole property of the chemist nor is the X-Ray the sole property of the physicist.

The Scientist, whether he be a teacher or a researcher is being asked by the layman to assume some social responsibility for scientific discoveries and their applications in the engineering, agricultural and medical fields. Diplomats, congressmen and clergymen as well as journalists and commentators are disturbed about where science is leading us. Are all these new scientific discoveries leading us to a realization of the "four freedoms" or are we heading for international suicide? The scientist cannot afford to leave the decision up to chance, nor can he afford to leave it up to the rabid militarist or the rabble rousing politician. There is a race on now among the great powers to assemble the best scientific brains to get there "fustest with the bestest" scientific army. Whether this great army is to be destructive or constructive is to a large part the responsibility of science itself. Science instruction in the future must be more than mere research into the laws of nature. We scientists cannot afford to ignore the social and moral implications.

It cannot be denied that college administrators and department chairmen are aware of the fact that there is a need for more and better trained teachers in all the sciences and we find isolated instances of attempts to improve science instruction. In the July-August 1947 number of the American Journal of Physics a pertinent article by A. G.

Worthing of the University of Pittsburgh Physics Staff deals in some detail with "A Basic Concept Course in Physics". This course had its origin in a desire to insure that teaching assistants in the department understood the basic concepts in the course and that they be capable of presenting these concepts to students under their charge clearly and consistently. In this basic concepts course in the fall of 1946 there were enrolled 56 graduate students mostly majors in physics but some majoring in other closely related fields. The course carries three semester hours of graduate credit for two semesters. The method employed in the course by Dr. Worthing is one of free discussion in which all the students participate openly to their heart's content. Much time is spent on problem solving and on the discussion of erroneous concepts. Clear and consistent definitions of physical terms are emphasized and mathematical short cuts are stressed. The course is popular with the graduate students because they see a direct application to their teaching. I heartily agree with Dr. Worthing in his concluding statement, "A course in the basic concepts of physics at the senior and the first year graduate level is very worth while." Furthermore, I have no doubt that a similar type of graduate course could have a definite place in any of the other natural sciences. This venture at the University of Pittsburgh to professionalize the teaching of physics is a noble gesture in a small though significant way.

Our graduate schools since the war are filling up again with thousands of young men and women looking forward to professional careers. In the sciences we have the professions of engineering, medicine, scientific research and teaching. Probably one half of the young Ph.D.'s in the Sciences during the next decade or two will try to apply their graduate training to the field of college teaching. These young people should be selected early in their graduate training. The graduate schools should devise some sort of aptitude examinations which have been skillfully prepared for the purpose of selecting future college and university instructors. Insofar as this applies to the sciences, I am not in any way attempting to divert anyone from a research career if his aptitudes and desires point in that direction. The Universities and industry as well will need all the research talent available in the foreseeable future, but I do not think it is fair to the teaching profession nor to the young people who are to be our future scientists if we do not furnish them with the best scientific instruction possible in the first two years of college. Our graduate science schools should attempt to train specialists in undergraduate and graduate instruction in the sciences just as they now train research specialists in nuclear physics, organic chemistry, bacteriology, parasitology, mineralogy and vertebrate anatomy.

The teacher of science should by all means first and foremost know his subject matter. In all probability he should be encouraged to have a specialty in which he should be urged to continue research as a part of his teaching load. Too many college instructors today complain that they are so heavily burdened with teaching, grading papers and committee assignments that they have neither time for

research nor for further study leading to professional growth. Department heads and college administrators should see that this be not so. Good teaching, no less than productive research should bring professional rewards in the way of promotion in rank and better salaries.

If graduate schools are to train better science teachers, these teachers must be trained in breadth as well as in depth. Physics, chemistry, and biology are all broad fields. Moreover, they are all overlapping and inter-related. Most of the students that college science instructors are going to meet are not going to be specialists in any of the sciences but they are going to be voters, tax payers and citizens. They should be given such science instruction as will best fit them for their future role in society. Science has a lot to offer and it must not be cheapened by poor and indifferent instruction.

Since it is entirely likely that some fifty per cent of our future recipients of graduate degrees in the sciences will enter the field of college teaching it seems entirely fitting that our science graduate schools should set up appropriate curricula for best meeting the needs of this group. This could be done without in any way cheapening the degrees nor lowering standards. Perhaps narrow departmental barriers will have to be crossed in order that our future college science instructors may have a broad cultural background. Perhaps basic concepts courses on a graduate level in biology, chemistry and even sociology and psychology might be extremely profitable for the physics graduate student who intends to enter the profession of college teaching. Similar reasoning might well be applied to graduate students in the other natural sciences including mathematics. Nature after all is not departmentalized; an oak tree is more than a botanical specimen, and stars, planets and nebulae are not the sole property of astronomers.

During the war our government together with others engaged in the war on both sides enlisted the services of the best scientific brains in the world for the purpose of winning the war. Since the ending of hostilities the federal government and industry as well are making every effort to encourage scientific research. Even on the secondary school level we see such enterprises as the "Westinghouse Search for Science Talent". All these gestures of recognition are extremely gratifying to scientists in general. However we must not "kill the goose that laid the golden egg". We must siphon some of the best scientific brains into the teaching profession. These are the scientists who are going to develop scientific thinking for tomorrow.

On the secondary school level a new program for the training of teachers has recently gone into effect in Indiana. Some of the members of this Academy have had a small part in setting up the science program. We are not altogether satisfied with our product but it is an honest attempt to furnish better science teachers to the secondary schools of Indiana. We think our secondary science teachers in the future will have a better academic background than those trained under past programs. We feel that these young teachers should acquire more than a knowledge of how to teach science. We hope they will learn some science to teach.

Without further elaboration let me bring this rambling discussion to a conclusion by summarizing the problem involved together with some suggestions for meeting it.

1. There is a definite shortage of well trained science instructors on the college level and this shortage gives promise of being further aggravated in the next decade.

2. Graduate training in the past in the various sciences has been directed in the main toward specialization in the research field.

3. In order that a research project be carried to a successful conclusion the trend has been toward rather narrow specialization in a specific compartment of a highly specialized division of natural science.

4. Our experiences in the war just concluded have proved conclusively that scientific training is imperative in a well rounded educational program. We have also learned that our educational institutions in the past have not given young people adequate background training in the sciences for military or industrial needs.

5. Colleges and even the better high schools are requiring graduate degrees for science instructors. These graduate degrees should be in subject matter fields and should be somewhat more comprehensive than degrees now offered in the sciences directed in the main toward research in a narrow specialized field.

6. The new trend toward general education is becoming more popular and science instructors engaged in this program are going to need comprehensive training in broad subject matter areas.

7. Willingly or not science is going to be compelled to assume some social and moral responsibility for scientific discoveries and inventions. The present world wide controversy concerning atomic energy has brought this issue clearly into the foreground.

8. Since some fifty per cent of our future Ph.D.'s in the sciences will in all probability enter the field of college teaching it would appear that science graduate schools should recognize this fact and take appropriate steps to direct a good part of the graduate training for higher degrees toward making well informed and broad minded science instructors.

9. Our future scientists are to be found among the thousands of young people now begging for admission to our colleges and universities. These young people deserve the best instruction that science can offer. It is neither right nor smart for Science departments to neglect these sources of potential strength by turning them over to poorly trained or indifferent instructors.

10. If science graduate schools consider that good science instruction is an important part of scientific growth it is logical to assume that the problem of supplying well trained science instructors for the colleges and universities should be attacked in a thoroughly scientific way. Future instructors should be selected early in their graduate careers by appropriate aptitude examinations. Serious study should be given to the kind of graduate training necessary for specific in-

struction in a given science field. If experience and sound judgment indicate that narrow departmental boundaries should be crossed to achieve most desirable results, ways and means should be found for doing this without in any way lowering standards or cheapening the degrees.

11. Teaching science in the colleges and universities should be considered on a par with scientific research by university administrators and science department heads, Rewards by promotion in rank and salary increases should be given for superior science instruction and time should be allotted for science instructors to carry on research of both a productive and professional nature.

12. The teaching profession in general and science teachers in particular long for the time when their profession will be accorded the respect now enjoyed by the medical profession and the research scientist. To attain this end science and those of us engaged in scientific pursuits will need to muster our best efforts. I believe that science teaching as a profession will become respected just as soon as it becomes respectable. To attain respectability superior college science teachers as well as superior physicians, superior engineers, and indeed superior cucumbers will have to be "grown on purpose".