Training Science Teachers

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There is no need to recapitulate the data relative to the shortage of science teachers. These data are well known to all of us. The only reason that I mention it at all is to emphasize our responsibility, as professors of science, to our society and to our nation in an attempt to recruit and improve the training of science teachers. Many school administrators inform me that the chief reason that science and mathematics are not offered in their respective schools is because they can not secure adequately trained teachers. We, as college teachers, must develop an awarness of the problem and give encouragement to those superior students who express a desire to teach. It would seem to me that this constitutes the main problem. Before more science can be taught in our high schools, we must supply them with more well trained teachers. I sincerely believe that it is better to eliminate science from the high school curriculum than to have it taught by someone who does not understand the philosophy of science.

The paramount objective of this paper is to discuss the training of science teachers. Before an intelligent discussion can be forthcoming, it is necessary to decide who is to be trained and the objectives to be attained by said training.

A teacher should be a much more broadly trained individual than that required for success in any other profession. I shall list, briefly, some characteristics which, I think, are important to the teacher other than mastery of subject matter. I shall have more to say about subject matter later.

A teacher must be altruistic. I realize that this statement is somewhat archaic, but the fact remains that one who teaches must have something of the missionary spirit. One must, at times, sacrifice his own desires for the good of all. Refusal to so act is to court failure in the teaching profession.

A teacher must be co-operative. I do not mean that one must sacrifice his own ideas, but once the policy has been determined by majority vote, then it is the teachers responsibility to follow that policy to the letter until it has been changed.

A teacher must have a personality which reflects friendliness, and confidence. This trait is not only important because it makes the teaching job easier, but because it is good public relations.

A teacher must be aware of his civic responsibility and to assume them. To do less is simply not good citizenship.

A teacher must have a deep love for young people. He must respect youth for its vigor, and must be tolerant of its shortcomings. I do not mean to imply that a teacher should assume the laissez faire attitude with regards to dicipline or to lack of mastery of an assignment, but rather that he solve the problem with tact and understanding. I realize that sometimes to handle a situation requires the patience of Job and the wisdom of Solomon, but good teachers often show a trace of both.

A teacher must want to teach. I am becoming tired of recruiting our teachers from fustrated engineers.

No doubt other desirable characteristics could be listed. I have mentioned these only as a means of indicating those traits other than academic achievement which should be considered in choosing those who are to be selected for the teacher training program. Obviously, if these characteristics are desirable, we must exercise extreme care in choosing those we wish to train. There are schools, I am afraid, who allow those who can not do anything else to enter the teacher training program. Unless a very careful screening program is followed, our classrooms will be managed by medicore people who will succeed only in perpetuating mediocrity.

After having selected the prospective teacher, we then can concern ourselves with his academic training. Since this discussion must be limited, I shall cover the training of secondary science teachers rather broadly and end with only a brief discussion as to what I think should be included in the training of the elementary teachers.

There are certain definite restrictions placed upon the colleges by the state board of education. Any teacher training program must be done within the framework so imposed. Because the degree is usually conferred upon the successful completion of 124 semester hours, our program is definitely restricted. But you must stop somewhere. I shall propose a program which is admittedly a compromise between what I should like to do and what I must do.

I believe that a science teacher should be interested in knowledge other than science. He should be able to use the English language with a fair degree of facility. He should be conversant with the principles of government. He should have some appreciation of the arts; music and fine art. He should have some knowledge of the history of his country as well as that of other countries. He should know something of geography. He should have a fair knowledge of mathematics. Time does not permit me to list many other areas which are of equal importance; these examples will serve, however, to illustrate the point I wish to make. A teacher must be interested and trained in a number of areas if he is to function best in the classroom. A good teacher, in my opinion, is one who has a profound interest in knowledge for the sake of knowledge. Someone has said than an educated man is one who knows everything about one thing and a little about everything else. It would be preprosterous to even intimate that we could possibly produce an educated individual in accordance with this definition during the four years we have him. The only thing we can hope to do is to instill into them the desire to learn and to give them some methods of study which will permit them to educate themselves. In an attempt to do this, most colleges require fifty hours in general education. I am not in sympathy with much of the current practice of offering survey courses in the various areas in order to achieve this general education, however, it is probably better than the over specialization that once plagued the educational pattern. I refuse to debate the question, because I am not sure that I have something better to offer.

In general, the state department requires that a teacher must have a Bachelor's Degree in order to receive a standard certificate to teach natural science in grades seven through twelve. The degree, however, is not enough. Fifty hours of general education, sixteen hours, ten hours, and six hours in each of the three main divisions of science, i. e., chemistry, physics, and biology, and also 21 hours of education is required. What kind of program taken by the student will depend upon his ultimate aim. If he remotely desires to teach on the collegiate level, then he should be directed into the program which more or less specializes him for biology, chemistry, or physics. This program should be only slightly different than that required of the straight science major. This should prepare him for graduate study in his respective field. On the other hand, those who wish to give a life of service to the youth of high schools would probably do well to obtain training in the natural sciences because in all probability he will be called upon to teach all the sciences in his school. The minimum requirements stipulated by the state board of education are much too small. By exercising their perogrative, the colleges may enhance this program to no small degree.

For instance, by instituting a major-minor combination which requires forty-two hours in the sciences, quite a variety of programs are feasible. Thus, one may select a biology, chemistry combination which requires courses chosen from the following:

Botany, Zoology, Entomology, Field Zoology, Oklahoma Vegetation, Physiology, Comparative anatomy, General Chemistry, Physics, or Geology.

This program provides for a minimum of 21 hours of biology, 10 hours in chemistry, and six hours in physics. Elective courses are required so as to make a total of 42 semester hours. This program will permit one to teach biology, chemistry, and general science in grades seven through twelve. It is strongly recommended that the prospective teacher take additional courses in physics so that he may teach that also.

This is only one pattern; other combinations are available, such as, Biology-Physics, Chemistry-Physics, etc.

These courses are the traditional subject matter courses in which the prospective teacher is taught something of the facts of science, and we hope, something of the manner in which these facts may be used in predicting new events and in correlating data. I sometime think that we are only fooling ourselves when we add this to our list of objectives, although we all try to achieve this aim.

Here I should like to interject an idea which, I am sure, is not new to you. The best training for a science teacher I can think of is for him to observe good teaching in our own classroom. I believe sincerely that young teachers, at least in the early years of their career, imitate the instructors who have made the most impression on them. The mere regurgitation of facts to the class is not enough. We should make every effort to clarify the principle, and show its application in examples. This may be done by demonstrations, blackboard talks, visual aids, or other methods. Problems should then be raised which require a knowledge of these principles for their solutions. As one man has so aptly stated, "Push them into a corner and make them invent a way out."

It has been previously indicated that careful screening should be done before one is allowed to begin his teacher training program. His failure to produce adequate performance in the academic courses should be sufficient reason to prevent his completion of the program. Simply refuse to recommend him for the practice teaching required of all who expect to teach. This should serve as an additional means of screening out the undesirables.

The state board further requires that a teacher must have a minimum of 21 hours in professional education. The following courses are desirables:

Principles of Secondary Education, Tests and Measurements, Child and Adolescent Psychology, Educational Psychology, Observation and Teaching, and Methods in Science Education. The latter should be taught in the science department, preferably by someone who has had some secondary school experience. This course should deal with selection of materials, setting up laboratories, how to make demonstration equipment, how to plan and present a demonstration, the use of visual aids, the method of making assignments, how to determine objectives and how to test for them, the use of the library, the construction of projects and how to display them, and above all how to teach one to think reflectively. As pointed out above, this may well be accomplished in the subject matter areas if the courses are taught by a competent teacher.

In my opinion this professional education requirement could be reduced to about 12 to 15 semester hours, if much of the duplication from course to course were eliminated. This is debatable of course.

Under the present conditions, this plan constitutes just about the best we can do at the undergraduate level. However, much can be done at the graduate level to improve the preparation of the teacher. Since the practice of granting a stipend of $200 per annum more to the person who holds the Master's Degree, most teachers have acquired a M. S. Degree in education. This only gave them more knowledge about how to teach and, all too often, nothing more to teach. It has been possible in more schools to acquire credits in academic courses as part of the program, but the pattern just mentioned has been the most popular.

Whether or not it is true, I have often heard the statement made that it was easier to secure a Master's Degree in education than it was in the subject matter area. Since I did not do mine in education, I am in no position to judge, but the fact remains that most teachers do take their masters in education.

Just recently the program has been instituted in the six state colleges in which the attempt is being made to encourage teachers to secure credit in the subject matter in order to increase their knowledge of their respective fields. The programs vary somewhat from one college to another, but in general the program is something like this: The teacher must take from 8 to 24 hours in professional education, or he may choose from 8 to 24 hours in subject matter area. This is as it should be if the program is designed to meet the needs of the teacher.

It was only last summer that the first class of people so trained were graduated, and whether or not it is superior to the old plan, can not at this time be determined. Only time will tell.

What is to be done on the elementary level? It seems to be the general opinion that if a profound interest in the sciences is to be developed and encouraged it should be started in the elementary grades. This, too, is debatable. Yet science in the elementary grades is often neglected. Often a real natural curiosity about his environment is very strong in a young child, and yet he receives very little or no instruction in science from that time until he reaches junior high school. During this period they tend to lose most of the natural curiosity. I can offer no explanation for this loss of interest, but I cannot help but believe that it is associated someway with the lack of instruction. To make any suggestion on improvements in training of the elementary science teachers would be somewhat presumptious on my part; but in looking over the catalogues of various colleges and universities, it seems to me that so much stress is placed on methods of teaching that the elementary teacher simply does not obtain the liberal education which will permit him or her to teach the child any branch of subject matter with any degree of understanding. Studies have been conducted which refute this statement.

A practice which has been in vogue for some years now is based on the premise that you are teaching whole child and not subject matter. I am in agreement, but I should like to add that you must teach the whole child something, and there is no good reason to think that if you teach one of the rudiments of arithmetic or science that you are depriving them of the opportunity of becoming a good citizen.

Most of the young women I know, who are training to be elementary teachers are so inadequately trained in elementary arithmetic, and science that they cannot teach either of them well. Since science and arithmetic are not understood by most elementary teachers these subjects are neglected in our elementary schools. One does not stress what he does not know. I do not know what to do about it, but in many of the schools 8 hours of general science are required in the general education program, and in some of the schools, at least a course in basic mathematics is required of all elementary teachers, but I am very much afraid that in both instances knowledge of these subjects is not required. Enrolling in the courses is synonymous with receiving credit in it. The basic mathematics course includes a little arithmetic, a little algebra, a little geometry, a little trigonometry, and a little business mathematics. This does not give the elementary teacher the kind of training necessary to teach arithmetic on the elementary level. In my opinion, and I sincerely believe this, it would be much better for the elementary teachers to have a thorough course in arithmetic. I believe that they then could do a much better job with teaching elementary arithmetic, and when I say a thorough course I mean one in which a mastery of the course is required. I see no reason why college credit should not be allowed for such a course.

Some colleges require, before one is recommended for the certificate, that the prospective teacher be required to pass an examination in English. Why could this not be required for arithmetic? This discussion, however, is supposed to be dealing with the subject of science, but the relationship between mathematics and science is so close that one can not discuss one without including the other.

Education Departments teach science methods to the elementary teachers, but I am not sure that our general science program, as it is now taught, provides sufficient information in science for them to understand the science method course. In my opinion much study must be given to the preparation of prospective elementary science teachers.

We must convince the elementary teacher that science is important and we must convince the school administration that science in the elementary grades is important, and believe me this is no small task.

I should like to suggest that this section of the Oklahoma Academy of Science institute or encourage someone to begin a thorough study of this problem. This would probably have to be done in co-operation with the department of education in the various colleges, suitable persons from industry, and persons from the state department of education.

To summerize, those persons who are co-operative, have respect for knowledge for its own sake, like people, have a sense of civic responsibility, are altruistic, and who want to teach, should be encouraged and selected for the teacher training program. These people should receive a background of general education, as thorough a training in subject matter as time will permit, and finally a background of educational psychology, educational methods, and educational philosophy. They should be encouraged to enhance their training by securing more credit in subject matter by pursuing one of the graduate programs now available. Finally something should be done to improve the training of elementary teachers, especially in the fields of science and arithmetic.