über Algebra, by Arnold Dresden; Richard and Petit's Théorie mathématique des Assurances, by E. B. Wilson; "Notes"; "New Publications."

## *THE QUIZ DEMONSTRATION SYSTEM OF TEACHING QUALITATIVE ANALYSIS*

It is time that we are awakening to the fact, that in the line of elementary laboratory work there is altogether too much poor impartation of knowledge. This is particularly the case as regards general chemistry and qualitative analysis, especially when considered from the standpoint of those who expect to carry on their life work in the field of engineering and industrial chemistry.

Qualitative analysis is especially subject to error. Who would think of trusting to a civil engineer, ignorant of the strength of the material employed, the construction of a bridge? Or one's child to a doctor, if cognizant of the fact that he did not know the properties of the drug he was administering? Is it not of as great import to a chemist that he understand the properties of the chemical elements, the material he is using in his daily work?

This being true, why is it that the laboratory instruction is, in many cases, left to assistants paid the munificent sum of from $200 to $500 per year, with, consequently, very indifferent instruction? If they are the best the institution can afford, the fault can be remedied, in part, by the man in charge giving to his assistants all the instruction within his power.

Detail laboratory instruction is the hardest of work, if rightly given, as difficult as any quiz or demonstration, for what is it, if properly conducted, but one continual individual quiz and demonstration of from two to three hours' duration? It is common to consider from two to three laboratory hours as equivalent to one lecture or quiz hour. This is a mistake, at least as far as the instructor is concerned, for it is not a greater impossibility for a man to lecture or quiz for half a day at a time, day in and day out, than for him to give the best that is in him to a laboratory class extending over a like period. I hear some one reply that it takes more time to prepare for a lecture or quiz than for a laboratory period. Granted, when the laboratory work is conducted as is most customary. But when the instructor keeps abreast of the times, makes a thorough test of the new methods, keeps track of and endeavors to overcome the difficulties of the ordinary class in qualitative analysis, he will devote much more time to the preparation of his work than a language teacher, for instance, who, year after year, employs the same text in class work. You see I am not making the statement, "He does this," but that he should. This is, of course, not possible when the hours of labor are too many to allow for it the requisite time. They should be shortened. There should be a certain amount of time spent by the instructor in his laboratory "doing things." A German teacher must know how to read the language. To teach laboratory work correctly a man must be able to do the work well himself.

Inasmuch as I am desirous of suggestions and criticisms from my fellow instructors, an underlying, selfish motive prompts me to present the scheme for laboratory instruction employed by me. It is one which I have successfully made use of during the past three years and I feel it a step in advance of the methods heretofore used by me, and of those which I have seen employed elsewhere.

Chemical theory is based on facts obtained in the laboratory. It is then true, that for a thorough comprehension of the theory it is necessary that the student be conversant with the facts before he can understand the application. I proceed, therefore, with this in view, as my main objective point.

As an essential, the instructor must see every test made by the student. That this may be accomplished the too often "drifting" about the laboratory by the instructor must be done away with. There must be system. There must be known, to some one in charge, what is going on in every part of the laboratory. Yet in this system, two things must be guarded against in the student. First, lack of independence. Second, useless waste of time, with consequent disheartenment and lack of interest in the work.

In considering Group I., consisting of lead, silver and mercury, the student is given a typewritten sheet of reactions to perform. These are carefully selected to bring out the properties of the elements, especially those which are of most importance in qualitative and quantitative analysis. At the completion of the experiments on silver or on silver and lead, in place of throwing out the contents of his test-tubes, the student takes them to the instructor in charge, and the latter, a man of experience, after examining the work carefully. gives him a thorough quiz on it. If this work, as well as the student's knowledge of the reactions, etc., is satisfactory, the instructor places his O. K. upon the sheet. If neither the quiz has been passed in a creditable manner nor the student been able to obtain the correct reactions, the contents of the test-tubes are thrown out and the work repeated. After a second trial, if the experiment is still unsuccessful, the instructor should demonstrate it. By this means the student is taught independence, there is created in him ability to do things for himself; the instructor is enabled to "keep tab" on the work accomplished, knows if the student has obtained the correct result and yet does not allow him to spend an undue amount of time on something which it is clear he does not understand.

This quiz demonstration system is varied to suit the needs of the individual. These, the instructor, coming in personal contact with each student as he does, soon comes to know.

Before the younger men of the force are allowed to quiz, they should observe the methods of the instructor in charge and then be subject to his direct supervision from time to time, when they themselves are quizzing. Thus, in as far as is possible, the policy of the laboratory is uniform and at the same time consistent with the individuality of the persons in question.

Upon completion of the preliminary work upon a particular group, the separation of the included elements is studied in a similar manner. When the results of this work have received the O. K. of the instructor the student is given a number of simple unknowns on this group. I find that by requiring that he do two of these for every one upon which he makes a mistake, his mistakes become fewer in number and his confidence in his ability thereby increases. In taking up the second and following groups, the separations and preliminary work are treated similarly to group one, except that when time is available one of the unknowns is made to contain one or more of the elements of the preceding group. In this way the separation of the various groups may be quizzed over as in the separation of each group.

The groups and acids take up somewhat over one half the time allotted to the course. Then come the general unknowns, where the work of the student is expected to be carried on independently. Several simple mixtures are first given, that the student may better connect the group separations. In these both the metal and acid are identified. Then follow a number of commercial products, consisting of minerals, slags, alloys, etc., the selection being governed, to a certain extent, by the particular field which the student is likely to enter. In this district mining interests are of most importance, hence, ores, minerals, slags, etc., make up this portion of the course.

Individual quizzing on this part of the work is not as frequent as before, but when reporting an unknown, the student is quizzed on reactions, method of separation, identification, etc. Here class-room quizzing is of more value and can be advantageously used to supplement part of the work with the individual, for, provided he be properly trained in the power of observation, a great amount of knowledge can be gleaned by the student from the mistakes of others, brought to his notice by this group questioning.

At this point too much stress can not be laid upon the exceptions to the general rules and the reason for each step taken in the separation. Herein is differentiated the training of the professional from the routine chemist. I find, also, at this point in the training, of the utmost importance, and yet one of the greatest difficulties encountered, is the mastery of the proper method of disintegration, especially of the insoluble substances and those which are likely to lose part of their content by volatilization. If a proper solution of the unknown is obtained, the analysis is comparatively easy, whereas, if not obtained, incorrect results are sure to follow. Alloys and metallurgical products containing relatively small amounts of some one substance also require special attention.

Objections have been raised to the use of technical products for unknowns, claiming that they do not give the proper amount of training. This is apt to be true where unknowns of a commercial nature are taken just as they come to hand without special effort on the part of the instructor. It is certainly not the case if care is taken in obtaining what is necessary to suit the problem in question, for there are certainly sufficient varieties of commercial products to cover the field. Aside from giving the students a training not to be had in the use of laboratory prepared unknowns, his interest is much more easily aroused and held when he can see something "practical" in what he is doing.

I have found that where lectures are combined not alone with class-room quizzing but as well with this demonstration method the student is made to think and gets a grasp on the subject well worth the time spent in its acquisition.

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## *HUMUS IN DRY-LAND FARMING*

IT has been the consensus of agricultural opinion and experience, both in this country and in Europe, that the production of wheat on the same land year after year results in steadily decreasing yields. Chemical investigations in several instances have shown this decrease in yield to be accompanied by a correlated decrease in the supply of humus and of nitrogen in the soil. Under the title of "The Nitrogen and Humus Problem in Dry-Land Farming," Mr. Robert Stewart, chemist of the Utah State Experiment Station, has recently published the results of some investigations with special reference to the effect of continued wheat growing on the non-irrigated lands of the Cache Valley in Utah.[1]

Mr. Stewart's investigations in the Cache Valley indicate that the continuous production of wheat in that section has not resulted in a reduction of either the humus or the nitrogen supply of the soil, at least during the thirty years or more that wheat has been so grown there. He finds, indeed, that in something over twenty cases where comparisons were possible between virgin soil and soil that had been cropped to wheat for several years there has been a slight increase, both in the total nitrogen and the humus in the surface foot. In the second foot of soil on these two sets of fields he finds a decrease of the total nitrogen on the cropped land, but a marked increase in the humus. His summary of results shows that on the wheat land there has been a 10 per cent. increase in the humus supply of the surface foot and a 25 per cent. increase in the second foot.

Mr. Stewart wisely avoids any generalizations upon the limited data he presents in this publication. But it is unfortunate that he does not give more consideration to the agricultural conditions and farming methods that prevail in the region of which he writes. Unless the reader of Mr. Stewart's bulletin is familiar with conditions in the Cache Valley, the results presented are likely to seem either pointless or irreconcilable with the results of similar investigations elsewhere. To one who knows those conditions, the brief statement that "Some of the farms of this district have been under cultivation for forty-five years, and apparently yield as good crops as they ever did" may seem to be a good and sufficient epitome of the situation; but if one does not know the region, this sentence hardly seems adequate.

It is true that accurate data as to the farm yields for past years are difficult to obtain and

[1] Utah Agricultural College Experiment Station Bulletin, No. 109, August, 1910.