

A LABORATORY EFFICIENCY TEST FOR ADVANCED STUDENTS IN CHEMISTRY

DAVID F. MCFARLAND, UNIVERSITY OF ILLINOIS

In recommending young graduates in chemistry and chemical engineering for positions in industrial laboratories and plants it is often desirable, if not imperative, to know something of their ability to do a large amount of work of more or less routine nature, neatly, accurately and acceptably, and their ability to work at times under high pressure without loss of accuracy or efficiency.

There is, unfortunately, little opportunity to measure these valuable traits with any accuracy in the usual laboratory work of the course. To be sure, much can be judged from the marked differences which are observable between the various individuals of a class in the neatness and accuracy of their work and in the promptness with which it is reported.

The daily class work can, however, scarcely be expected to afford favorable opportunity for tests of efficiency. The main object of the course is to teach fundamental principles, and standard or selected methods based on these principles. The attention of the students is focused upon these and not upon any ideas of economy of time, or real efficiency of operation.

It was with the view to developing some test or series of tests that would serve to measure the different members of graduating classes that the work herein described was begun five years ago.

It was inaugurated as a laboratory examination in a course in fire assaying in which 20 or 25 senior and graduate students are annually enrolled.

This course affords a considerable number of analytical determinations of the same general type and the student has an opportunity to learn fairly well the main details of procedure, the sources of error and how to avoid them, and the chances for saving time and labor.

An effort is made as the course proceeds to get him to plan his work with a view to efficient utilization of time and to watch for improvement in the technique of his operations.

No attempt is made, however, to assume that he can be made an expert assayer in the short time allotted to the course. That is manifestly impossible, and is not desirable for students of this class since very few of them expect to do any assaying after graduation.

The conditions of the "efficiency run," as the test was designated, were posted several days in advance.

Each student of a squad of five was to be given four finely-ground samples of ores, offering no exceptional difficulty of treatment, one day before the time of the run. He was to examine each sample carefully; make any blowpipe, vanning, or other tests which are needed to identify the minerals, and prepare a statement of the nature of the ore, its gangue and the charge which he intended to use upon it. He was allowed to stock up on materials and to put apparatus into condition, but was not permitted to make any weighing or to mix any charges.

At the time appointed for the test each contestant was given a furnace, ready heated to a proper working temperature, and the run was started. The control of the furnace thereafter was entirely in his hands.

The time of beginning and of the finishing of each stage of the assays was recorded by the instructor and records made of neatness, judgment of temperatures, (checked by the instructor's pyrometer), ability to keep up fires in the furnace, smoothness of operation, exhibition of patience or impatience, evidences of miscalculation or bone-headedness, etc.

Grading was made on the following scale: Accuracy, 35 per cent; neatness, 22.5 per cent; speed, 22.5 per cent; judgment of composition and treatment of ores, 10 per cent; judgment and control of temperatures, 10 per cent.

Reports were required to be neatly written upon blanks furnished for the purpose and the complete report had to be handed in before the run was considered finished.

Accuracy was estimated on the basis of average results obtained by the men of the same class under the more leisurely conditions of their previous work.

Of all the factors involved, the one of speed appealed most strongly to the individuals making the run, and from the first there was evidence of a tendency to reduce the whole test to one of speed.

With this in view, some wonderful systems of operation were devised, with shortcuts that were more or less fallible and often with difficulties quite unsuspected by the authors of the systems.

The failure of these systems brought out many individual peculiarities and revealed some temporary lapses in temper and nerve control. In some cases a slight accident to the assay would serve to upset a man's whole plan and leave him floundering and apt to do many foolish things.

A fine opportunity was afforded to study the ability of the contestants to work under fire and to detect their strong as well as their weak points.

In spite of frequent admonitions to the effect that "not to the swift is the race," the sporting instinct urged a speeding up, and the time records were rapidly broken again and again by successive squads and in succeeding years. An amount of work which required twelve or fifteen hours at least in their earlier career was turned out in a little over two hours by the speediest men.

The results were not so satisfactory, however, when judged from the *most* important angle of accuracy. Even when judged by the average of the current class, they were far from accurate as a rule. Moreover, penalties for gross errors of judgment, carelessness and noncontrol of temperatures, were more frequent than was desirable.

It was evident that the element of accuracy was rated too low, and a new scale of grading was used in this year's run, as follows:

Accuracy, 60 per cent; neatness, 15 per cent; speed, 15 per cent; judgment of ores and charges, 5 per cent; judgment of temperatures, etc., 5 per cent.

This has resulted in a very great improvement and has given some records that are highly satisfactory in accuracy as well as

in other respects. The whole tone of the run has been raised and neatness has been enhanced. At the same time speed has not been lessened.

After five years of operation the test has shown itself of very great value both to the student and to his instructor.

It has fulfilled its object of affording a reasonable measure of the manipulative skill and judgment of the individual students and has been of use in describing these qualities to prospective employers.

By far the greatest benefit, however, has come to the students themselves in arousing their interest in the planning of their work to secure efficiency, and in bringing about through this planning a much more thorough review of the whole subject matter of the course, than can be induced by any other method.

The various systems and plans of operation are vigorously discussed by the contestants before their runs and methods that succeeded with one are quickly adopted by others.

During the contests interested spectators gather on the side lines and discuss the chances of their "favorites" winning.

The posting of the final scores with their clear demonstration that speed without care and good judgment is a fruitless waste of endeavor, in an analytical laboratory, is very wholesome in its effects.

The principle of efficiency runs is one that can be utilized in many laboratory courses not only in chemistry but in numerous other subjects, and it is possible that its application in a number of lines might offer the best kind of data for a rational basis of recommending men for positions.

At any rate, it is commended to other teachers for trial.