recovered. There was dissolved, therefore, from the original residue left after the preparation of solution No. 4, a total of 14.32 per cent lime and 10.43 per cent sulphur in a total of 1390 cc. of finished product. Summing up, the original residue yielded a total of 25.26 per cent lime and 32.73 per cent sulphur by the foregoing treatment, and 1980 cc. of finished product were obtained. The series 12*a*, *b*, *c*, *d* and *e*, showed substantially the same results. As a result of repeated treatments of the residues in this series with water, 4460 cc. of finished product were obtained before practically all of the lime and sulphur in soluble form had been extracted. It will be noted that the final solution prepared, No. 12*e*, contained only a small amount of dissolved lime together with just a trace of sulphur.

It is quite apparent that the soluble sulphides, which were subsequently dissolved in the finished product by the repeated addition of water to the residues, were formed, during the concentrating and boiling of the original mixture, and that further treatment of the residue with water supplied the necessary solvent. If the assumption just made is correct a large quantity of the soluble sulphides, remaining in the residue after removal of the concentrated sulphide solution, could be obtained by washing the residue with additional hot or cold water. In this manner a definite quantity of finished product could be collected each time. It would seem that this procedure would be much more satisfactory than that of collecting only the liquid which separates from the residue, the amounts of which cannot help but vary each time the preparation is made. The N. F. directions specify that the mixture of lime, sulphur and water be concentrated to a volume of 1000 cc. and maintained at this volume, while boiling, for one hour. Experience has shown that it is quite difficult, if not almost impossible to keep the volume constant. The solution necessarily has to be prepared in large containers and any little variation in volume represents a relatively large increase or decrease in the amount of finished product obtained, and hence the percentage strengths of the lime and sulphur will seldom if ever be the same in different solutions.

This investigation is being continued. An analysis of the residues and of crystals forming in the solution is now being carried on.

UNIVERSITY OF WASHINGTON COLLEGE
OF PHARMACY, SEATTLE.

A COMPARISON OF RESULTS OBTAINED BY TWO METHODS OF INSTRUCTION EMPLOYED IN TEACHING PHARMACEUTICAL CHEMISTRY.*

BY CHARLES H. RODGERS.

In the presentation of the subject matter of any course of study an instructor is confronted with the pedagogical problem of how to present the particular course material in order to get the best results with an especial student group immediately at hand. To correctly determine what is the best method that should be used for a certain student group is not a simple matter, especially since the instructor usually has little or no advanced information on the average scholastic ability, coöperative desire and interest of the students in the group. An experienced instructor will

* Section on Education and Legislation, A. PH. A., Madison meeting, 1933.

usually "feel his way" with a new class, departing from the scheduled lecture and quiz periods by increasing the one and decreasing the other, as he thinks best, until he has found the combination that he believes to be the most satisfactory.

The problem is further complicated when the quantity of material covered by a course of study is very large and the number of lecture, quiz and laboratory hours assigned to the course is small. The course in which comparative studies of the results of several teaching methods has been made is designated as Pharmaceutical Chemistry. Three lectures, one quiz and three laboratory periods of fifty minutes each for the winter quarter of 12 weeks, and three lectures, one quiz and four laboratory periods of fifty minutes each for the spring quarter of 12 weeks, or a total of 180 actual hours, are allotted to this course. The course is intended to cover those facts about the elements and their compounds which are of especial interest to pharmacists. Such a consideration will naturally include official Latin and English titles, common names and synonyms, empirical and structural formulas, official definitions and rubrics, descriptions and physical properties, tests for identity and purity, pharmacological action of ions, chemistry of pharmaceutical preparations, industrial methods of manufacture, etc. The laboratory work includes the manufacture of a number of chemical compounds by processes as nearly like the actual industrial methods as possible. The student is provided with a textbook covering the material.

The vast amount of material in such a course precludes a *detailed* lecture presentation by the instructor and still reserves sufficient time for satisfactory quizzing and laboratory work. When the *most important* facts *only* are lectured upon and one oral or written quiz conducted once a week, it has been found that most students delay studying their notes made in lecture and also that portion of their texts covering the subject matter of the lecture until the evening immediately preceding the weekly quiz. This they *would* do despite advices to study concurrently with the lectures. This was proven time and again by giving unannounced quizzes upon the material presented in lecture on the preceding day and also by students confessing that they had to study in this way because of a heavy schedule. The average of student grades made on three unannounced written quizzes was about 62 per cent with only eighteen (18) making passing marks of seventy or better. However, when a similar quiz was *announced*, the general average was 79.2 per cent with only twenty per cent of the class having grades of less than 70 per cent but greater than 61 per cent (61%). When the same identical written quiz was given unannounced two weeks later, the examination average showed a general decrease of approximately 10 per cent. When given after four weeks, the decrease was only 12 per cent. Sufficient data were collected to show that announced quizzes given frequently had the coercive effect of making students study concurrently with the lectures.

The assignment of daily lessons from the text and utilizing the entire time scheduled for didactic work for oral quizzing was tried for several weeks. When questions dealing with O. L. T. formulas, common names, etc., were asked, the oral quiz marks were quite satisfactory. However, when the questions had to do with technology, ion actions, processes, etc., the answers showed a distinct lack of clear understanding. This emphasized the necessitv of explanatory lectures on certain phases of the work.

During the third quarter of the 1932–1933 school year it was decided to try the following method. The daily assignment of work to be covered on both lecture and quiz days during weekly periods was posted on each preceding Thursday. Immediately upon reporting for class the students wrote a twenty-minute quiz on the material assigned for that particular day. The papers were then passed to neighboring students who corrected them during the next thirty minutes, which the instructor devoted to a lecture covering all of the questions asked in the quiz immediately preceding the lecture and, also, to any other material in the assignment needing explanation but not covered by the quiz. The papers were handed in at the close of the period and carefully reviewed by the instructor, who then returned them to the students for study.

After pursuing this plan (Plan A) for six weeks an examination on the subject matter covered in that time was announced. The average grades for these papers was 79.8 per cent. On the other hand, when three full period lectures and one oral quiz each week were given for six weeks (Plan B) and an announced quiz given on the material covered, the average for the class was only 62.56 per cent. When Plan "A" was employed, the student average grade on the announced quiz showed 17.24 per cent higher than that obtained when the second plan, "B," was used.

The estimate of time spent by students in the immediate preparation for the announced-written-quiz given after using Plan A was one and one-half ($1^1/_2$) hours per student. (Data obtained from approximately 50% of the students in the class —students selected at random.) Inquiries as to the time spent in the immediate preparation for the announced-written-quiz given after following Plan B showed an average of approximately three hours per student. There can be no question but that students spent more time in the aggregate preparing for the announced-written-examination given under Plan A and that this time was put in uniformly throughout the preceding six weeks (each night preparing for a 20-minute written test the following day), and furthermore resulted in obviating the necessity of devoting a long study period immediately before the written examination.

The "written-quiz-lecture" system, which we have used successfully, is not advanced as a new pedagogical method. As previously stated, it is the desire of every true teacher to use that particular method of presenting his subject which will result in the greatest benefit to his students. From the composite data collected to date, as well as from the observed general results, we believe that this method is by far the best one employed by us in teaching Pharmaceutical Chemistry. This plan does not necessarily work for other courses. For example, we have tried the method for several weeks in a course in Operative Pharmacy but have come to the conclusion that for this course the lecture-oral quiz plan gives better results.

It is our opinion that the written-quiz-lecture system is a mildly coercive way of inducing students to work for themselves and, when this is accomplished, the problem of the instructor is materially simplified.

Dedication of the American Institute of Pharmacy at Headquarters Building, Wednesday, May 9th, at 10:00 A.M.