may direct. On the return of the expedition you will be expected to superintend the distribution of specimens to specialists approved of by the two councils or their representatives, and to edit the resulting reports. You will also be expected to contribute a report on the scientific results of the expedition for the official narrative. As it may be desirable during the progress of the voyage that some new scientific discovery should be at once made known in the interests of science, you will, in such a case, inform us of it by the earliest opportunity.

7. You and the other members of the expedition will not be at liberty, without our consent, to make any communication to the press on matters relating in any way to the affairs of the expedition, nor to publish independent narratives until six months after the issue of the official narrative. All communications are to be made to us, addressed to the care of the secretary of the National Antarctic Expedition, London.

8. Should any vacancies in the scientific staff occur after the expedition has sailed from England, you may, with the concurrence of the commander, make such arrangements as you think desirable to fill the same, should no one have been appointed from England.

9. You and the members of the scientific staff will be cabin passengers joining the expedition at your own risk, and neither the owners nor the captain are to be responsible for any accident or misfortune which may happen to you. You will obtain from each member a letter to this effect.

The instructions are signed by the Presidents of the Royal Society and the Royal Geographical Society.

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*TEACHING OF CHEMISTRY IN SCHOOLS—1876, 1901.**

BEFORE comparing, or contrasting, the teaching of chemistry twenty-five years ago with that of to-day, it seems desirable to trace briefly the evolution of chemistry from a much earlier period. This will enable us to see at what part of the evolutionary line high-school chemistry had arrived when the American Chemical Society was founded, and where it now is.

In the alchemistic age the effort was to conceal, not reveal, facts. All the language is most obscure, and writers are pervaded with the idea that the wrath of God will rest upon them if they reveal the secrets of their laboratories. Basil Valentine says he fears he has spoken so plainly that he shall be doomed at the last great day; but the modern French writer Figuier facetiously remarks that all the adepts who have ever tried to decipher his language regard it as certain that he was one of the elect. There was no teaching, as there was no science. A little later, when an alchemist disclosed the philosopher's stone or the elixir it was to a few persons for large money considerations. If he made pretended transformations into gold in presence of spectators, the *methods* were kept secret.

With the advent of scientific chemistry, even among the phlogistics, secrecy became a lost art. Experiments began to be written about and talked of, but were not at first made in public. Books contained no illustrations. The question and answer method got into chemistry as in all other teaching. Jane Marcet's little book 'Conversations on Chemistry,' first published in London in 1806—which ran through 20 editions and was revised as late as 1855—set two generations to thinking of the marvelous revelations of nature. It consisted wholly of questions and answers, only the later editions being illustrated.

With the Lavoisierian chemistry—in fact, antedating it somewhat—came the demonstrative lecture method of teaching. As the professor—for this was a feature of colleges and medical schools only—performed his

* Read at the 25th anniversary of the American Chemical Society.

experiments before the class, and called attention to the phenomena, which he explained either by phlogiston or according to the doctrine of Lavoisier, his hearers gained much. If there was still something of the alchemistic glamour, the subject could be studied afterwards in a suitable text-book. All in all, it was the most noteworthy advance in teaching that had taken place up to that time. As the question and answer method will never disappear from educational systems, so the best in the lecture method came to stay, and will always have its place. But it was far from being ideal, or final. During that period the man who could deliver the most faultless lecture was the best teacher.

But another step was to be taken, in which, in place of a passive observer, the student must prepare and set up his own apparatus, mix his chemicals, adapt the conditions, watch the phenomena and arrive at conclusions. This was a more radical revolution than even the lecture method, and it merits more than passing notice. Liebig is accredited as the inventor of the laboratory method as applied to chemistry. This method, transplanted in America by one of his pupils, Eben Horsford, who in 1848 was appointed professor of chemistry at the Lawrence Scientific School, Cambridge, Mass., gained a slow and struggling popularity. It was at the same institution and about the same time that Louis Agassiz began to employ the laboratory method in natural science. In 1850 Professor Cooke fitted up as a laboratory, mostly at his own expense, a basement room in University Hall at Harvard College, where a few selected students were admitted. There was no gas or running water. After seven years more, against great opposition, he succeeded in having laboratory work a requirement for Harvard students in chemistry. The first laboratory instruction in chemistry for *medical students* in this country was in 1853 at the Harvard Medical School. It took another quarter of a century for the laboratory idea to permeate any but the larger colleges, and chemistry continued to be taught by the recitation method. One of the earliest, perhaps the first, secondary school to adopt the new idea was the Girls' High and Normal School of Boston, about 1865. It was followed by the Cambridge, Mass., High School in 1866, and the English High of Boston, in 1871. One of the early teachers says: "A chemical laboratory for pupils was a rarity; all foreigners and visitors to the city were brought to see it, and they opened their eyes in amazement at the strange sight." This was in 1870, and plans and photographs of this workshop for students were in demand from various parts of the United States.

But, generally speaking, the laboratory method, as regards high-schools, is a development of the past twenty-five years. A new era in chemistry teaching was dawning. It was greatly stimulated by the summer schools of science which sprang up in colleges all over the land. The first teachers' school of science was that of Louis Agassiz in natural history, held on the island of Penekese during the summer of 1869. In subsequent years this school, enlarged and broadened to include chemistry and other branches of learning, was held in Cambridge, Mass., the example of Harvard being followed by other institutions, and the laboratory idea was spread broadcast.

At first the workshop was usually put in the basement of the school building, and laboratory work was an extra subject, or voluntary exercise to be done after school hours by those sufficiently interested; hence very little was required. As the work grew and its value became apparent, note-taking was introduced. 'Observation' and 'conclusion' made up the notes, mostly mechanical, without much connection. After a time, this being found insufficient, the teacher tried to put the student in the attitude of an investigator. He must describe the apparatus—which he has himself set up—the chemicals and how he has mixed them, the operations he has performed; must trace the phenomena and try to ascertain what the experiment shows, must test his products, and, so far as he is concerned, do real, original work. Finally he must write out in fairly good English all the above operations, observations and results. Later on, when he becomes somewhat familiar with the principles of the science, problems of a practical nature are given him to solve—to make given compounds, or to separate mixtures. This leads on to qualitative analysis, a brief course in which is quite generally taken now in the high-school, always following general chemistry and often put into a second-year course.

This accuracy of detail naturally led to two further developments: (1) A logical or scientific sequence of experiments. (2) Quantitative work—which is one of the latest phases of this method. In fact, quantitative work for beginners, who have not had thorough training in general, qualitative manipulations, is still a doubtful experiment—one which the colleges, technological and medical schools, are so far answering, for the most part, in the negative. Those in favor of the scheme in elementary work reason that it inculcates greater accuracy and skill in manipulation than mere qualitative work, gives the student an idea of research methods, and makes his work complete. The opponents claim that to a beginner the underlying facts and principles of science are of paramount importance, that the *qualitative* in evolution precedes the *quantitative*, and—since time is limited—research methods are better suited to such students as pursue the subject further. A well-known teacher writes: "The attempts to beat out methods theoretically correct, the putting quantitative before qualitative and the ignoring of the great primal facts which lead easily into those parts of the subject which concern the great body of men and women, have a tendency to lessen the interest."

The introduction of the laboratory method presented a new problem. When text-book work was the only feature, every chemistry hour was a reciting period. With the advent of the lecture table came a division of time between demonstration and recitation. The laboratory feature necessitated a further division, involving the question: How much time, relatively, ought to be given to laboratory, to lecture and to recitation? In the solution of this question there has been no unanimity, rather the greatest diversity, of result, each school with its peculiar environment making its own answer. In some instances the entire time is devoted to laboratory work, and in such cases the text-book is usually discarded. A new method always runs to extremes in individual cases. As a recent writer says: "Chemistry has suffered from the irresponsible wave of laboratory madness which has swept over the whole educational world. Laboratory work has been carried far beyond its limits, and things have been expected of it which it never did and never can do." It seems safe to believe that the problem will finally resolve itself into a proper equating of the time ratio between text-book, lecture work and laboratory.

Another outgrowth of the last quarter is the conference, and reciprocal recitation—to coin an expression—in which the student becomes a questioner and the teacher recites and explains. The great value of this method—which may take up half or the whole of a recitation period—can be revealed only on trial. It shows what the teacher never knows before hand, *viz.*, the standpoint from which a pupil views a subject, and that, after all, is the case to be diagnosed. The opposite view that nothing should be told the student, but everything evolved, by a series of questions, from his brain—callow and ignorant of first principles though it be—is still advocated by a few in authority. It is the inductive method gone to seed.

Applied to chemistry teaching the inductive method, though in use earlier in some schools, was largely a growth of the decade beginning about 1885. The first text-books avowedly inductive began to appear. Like other good things, this Socratic, time-killing process was almost run into the ground by enthusiasts. Newth says: "In actual practice the *purely* inductive method of instruction breaks down. There is so much that the student is required to learn that life itself is not long enough, and certainly the limited time at the disposal of the student is all too short to admit of his going through the necessarily slow process of gaining this knowledge by his own investigation."

That part of induction which has the stamp of perpetuity consists in the teacher's quizzing the student while the latter is making an experiment. In this manner a world of thought and suggestiveness may be opened up to the imagination, and the method thus employed subserve a highly useful end.

In some schools the time allotted to chemistry is not more than it was 25 years ago, and certain laboratories blossomed into full maturity almost at the outset, but not so with the great majority. The chemical theory is taught more effectively now than then by the use of charts and blocks. Laws which cannot well be shown by experiment are illustrated by simple mechanical devices and diagrams, so that, instead of mere words, the pupil can get a clear mental picture of the given law. Many problems in practical chemistry are introduced and the bearing of equations, valence and stereochemistry is studied as it was not 25 years ago. *Non multa, sed multum* is the watchword of the best teachers in chemistry, as in other branches. How much these improvements are due to the meetings and the *Journal of the American Chemical Society*, it is impossible to state. In the dissemination of chemical knowledge this magazine has been a great power. The history of important chemical discoveries, and something of biography are also taught in high-schools to-day. Instead of one text-book, students in the best schools have access to a large number of books and are encouraged to do outside reading in scientific periodicals.

What then have we found in high-schools as the result of our inquiry?

In 1876 a prevalent view that chemistry has little educational value.

In 1901 chemistry found in practically every high school curriculum.

In 1876 school committees very loath to expend anything for laboratories or equipment.

In 1901 the laboratory and lecture room among the first considerations in constructing a high-school building.

In 1876 practically no laboratories, the text-book recitation dominant, very few demonstrative lectures.

In 1901 chemical work mostly divided into lecture, laboratory and conference periods.

In 1876 no notes of work.

In 1901 notes containing description of apparatus, manipulation, chemicals, phenomena, inferences, reactions, couched in more or less correct English.

In 1876 deductive methods almost wholly.

In 1901 methods partly inductive, partly deductive.

In 1876 the student committing facts to memory.

In 1901 the student more or less an investigator.

In 1876 a smattering of general chemistry only.

In 1901 both general chemistry and qualitative analysis, with some quantitative work, to illustrate laws.

The object and aim of chemical study in the two periods may be illustrated by excerpts from the prefaces of two books. The one in 1876 says that the author "has sought to make a pleasant study which the pupil can master in a single term, so that all its truths may become to him household words. This work is designed for the instruction of youth and for their sake clearness and simplicity have been preferred to recondite accuracy."

The 1901 author says: "The tendency of the present day is to make the student, from the very beginning, an *investigator;* to train and develop his faculties for observation; to make him find out facts and discover truths for himself; in other words, to make him *think* instead of merely committing to memory what others have thought."

What will be the next progressive movement in secondary-school chemistry? Already a few dim shadows are being cast which may materialize. In schools of the larger cities there is a growing demand for elective courses and elective studies in every department of learning. Elective *courses* are not a new idea, but should high-school pupils be allowed to choose *all their studies* throughout a three or four years' course, it would profoundly affect the scope of teaching and indirectly the methods. Another coming event is the reaching down of chemistry into the grammar grades. This has been successfully done in some few cities and towns. Should the grammar grades teach chemistry and the high-schools have elective studies, the higher grades of quantitative, volumetric, organic and theoretical chemistry may be forced into the high-school, and a minimized university result.

Another indication is that of cooperation. Chemistry teachers are beginning to form associations for discussion of methods and aims. There is at present a wide diversity in methods of chemistry instruction. While these can never be wholly unified, nor is it desirable that they should be, owing to varied environments, yet discussions of methods, aims and results are most stimulating, and secondary schools may, in this respect, take a step in advance of colleges and universities. Magazines and periodicals for the discussion of what is latest and best in science-teaching mark also the new era, and are an indication in the same direction. The *Journal of the American Chemical Society*, whose 25th anniversary we celebrate to-day, may join hands with its infant sister, *School Science*, the youngest representative of scientific education.

From the twentieth century aspect of chemistry study, is it too much to say that it realizes more fully than perhaps any other single subject the ideal for combined manual, observational and intellectual training?

RUFUS P. WILLIAMS.

SCIENTIFIC BOOKS.

Public Water Supplies: Requirements, Resources, and the Construction of Works. By F. E. TURNEAURE and F. H. RUSSELL, professors in the University of Wisconsin. New York, John Wiley & Sons. 1901. Octavo. Pp. xiv + 746.

This volume has been prepared with particular reference to the needs of teachers and students in engineering colleges, and it is from this point of view that the following remarks are made: The field covered is a large one and in no other branch of engineering has there been a greater growth during the past twenty-five years. In particular the methods of purification of water have, by the aid of the sciences of chemistry and bacteriology, become so thoroughly understood that they are now of equal importance with the operations for storage and distribution.

Part I. of the volume, covering 197 pages, relates to the sources of supply, rainfall, flow of