Teaching the History of Chemistry in Japan*

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Abstract:*** After describing the place of the history of chemistry in the Japanese system of secondary and higher education, the author cites his experiences in three types of courses: (1) a chemistry course for non-science students with liberal use of historical background material intended to acquaint them with actual scientific procedures; (2) an elective general education course in the history of science (Part I: Physics; Part II: Chemistry) for both science and non-science students, primarily utilizing Conant's "case study" approach; and (3) a five - semester program for training professional historians of science or chemistry. Special problems are then discussed such as bridging the gap between the modern scientific, technological culture rapidly assimilated from the West in the century since the Meiji restoration and Japan's traditional cultural values. Finally, the activities of Japanese scientific societies and journals with respect to the history of chemistry are considered.

This paper is based chiefly on my personal experience in teaching but I hope that it might give more or less a general scope for the status of teaching the history of chemistry in Japan.

In the early decade of the nineteen-twenties when I was student in the chemistry department of the University of Tokyo, professor Yuji Shibata, now president of the Japan Academy, gave us a lecture on inorganic chemistry, which was not mere information of the systematic knowledge of this field but accompanied by the historical introduction for every main subject. I remember that his lecture was particularly inspiring because of such treatment of subjects which otherwise might have been rather monotonous.

Soon after when I began to teach chemistry to students of a preparatory school for universities of the pre-war system of this country, I could hardly find

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time for weaving the historical background in my course plan for introductory chemistry, though I endeavoured to give students interest and stimulation in learning chemistry by telling them occasionally the history of some remarkable chemical discoveries.

My own interest for the history of chemistry, however, gradually increased through the teaching experience and I later became to believe that some pre-training in the study of the history of chemistry should be a requisite for every good chemistry teacher. I also remember that the *Journal of Chemical Education* began to be published in 1924 by the American Chemical Society just when I started my career as chemistry teacher and that, since then, how much I have been profited and stimulated by articles on the history of chemistry which now and then appeared in this journal.

After World-War II the educational system of Japan has been radically changed. We adopted the so-called six-three-three-four year school system after the model of the United States in place of the pre-war German type system. At present, the teaching of chemistry as an independent subject begins at senior high school, of which a certain number of credits are required for all students who enter colleges and universities. There is a minimum standard for the course plan of the secondary school chemistry set up by the ministry of education, where no special indication is given on teaching historical topics, although many high school text books are usually illustrated by the portraits of great chemists and appended by the chronological table of Nobel-prize winners or important chemical discoveries. On inquiry during these several years I have found that interest or knowledge of college freshmen in historical matters is generally poor and immature. Out of students of a whole class only some 10-20 percent students can give satisfactory answers for such questionaires as: what are the chief works of Lavoisier, Dalton and Mendeleef and approximate ages of their publication? This seems to indicate that secondary school students are rather crammed up by actual chemical facts to be memorized.

In Japanese colleges and universities the undergraduate course consists of two parts, namely the general education course and the specialized education course. The former covers usually the beginning three semesters, while the latter covers the rest five semesters, one academic year being divided in two semesters.

Accordinly, chemistry is also treated as a subject of the general education program which is commenly further classified in two course plans: one for science students and another for non-science students. The former plan usually takes a pattern of 'general chemistry' like Linus Pauling's well known text book, whereas the latter takes various forms and contents according to instructor's choice and inclination.

Teaching the history of chemistry is naturally a problem concerned with either the course for science students or that for non-science students. From my point of view it is supposed that every chemistry department of college or university should provide some practical plans for teaching the history of chemistry for both types of students. In actuality, however, curricula set up by most chemistry departments in our institutions look too tightly filled up to spare space for teaching the history of chemistry. For science-major students, even in the course of introductory chemistry most instructors feel shortage of time for handling historical subjects, because teaching materials of modern chemistry are ever increasing. In such a situation it is rather natural that our experiences in teaching the history of chemistry have been mainly relevant to the course for non-science students in liberal education programs.

In these eighteen years I have been occasionally engaged in teaching chemistry for non-science students at the University of Tokyo or at Tokyo Woman's Christian College and upon this teaching experience I have written a text book[1] where I tried to treat some important concepts in chemistry, such as atoms and molecules, ions, nuclear atoms, chemical bond, chemical affinity, reaction equilibrium and kinetics, structural isomerism, macromolecules, etc., on the background of their historical development. For example, when I treat the concept of 'ions' I first introduce students into the phenomenon of electrolysis through the demonstration experiment on the solution of zinc bromide, as an example, to give them visual impression of the separation of elements at positive and negative electrodes and tell them how Faraday came to the notion of 'ions' as moving particles carrying electricity. Then I touch on the work of Hittorf of determining relative velocities of anions and cations under given electric field. After showing demonstration experiments on the electric conductance through gases, I explain how J. J. Thomson came to the discovery of electrons. Meanwhile students carry out in laboratory the determination of the Faraday constant and

further learn about Millikan's work on the determination of the elementary charge.

By comparing these two quantities students can conceive of 'ions' as particles carrying elementary charges in simple whole numbers. After going through the story on the discovery of atomic nucleus by Rutherford I proceed to explain the Bohr models for the atomic structure without going into detailed mathematical treatment of the theory. On the basis of such models students can finally grasp features of hydrogen ion or other ions as atomic nucleus or kernel deprived of some whole numbers of outer electrons.

This course is however not a course of the history of chemistry but rather a course of chemistry referred to its historical background. I presume that such a method of introducing chemical concepts as above exemplified should be effective in giving students an understanding for the actual scientific procedure which is to be considered one of the most important objects of teaching chemistry for non-science students. Though I am not still certain if my attempt has been quite successful, I could find at least some progress in students' understanding for scientific thinking and their appreciation in historical subjects through their response to questionaires in final examinations.

It is often pointed out that in liberal education it is important to give students understanding for the relation of science to the general human cultures. For this purpose it might be more adequate to design a course for the history of chemistry (or science) as a single subject in curriculum and treat it on the basic idea suggested by George Sarton.[2] The traditional outline course on the history of chemistry would be rather tiresome to ordinary students, while the method of case histories proposed by J. B. Conant[3] is to be considered more effective.

In Tokyo Woman's Christian College there is a course for the history of science in the general education program open to both science and non-science students. This course is a one-year course, consisting of two parts: part 1, which is taken charge by Dr. Watanabe, includes such topics as: astronomy from ancient through Copernicus to Newton, studies on the nature of heat by Carnot, Rumford, Joule, and Helmholtz, science in relation to religion and literature in the seventeenth and nineteenth centuries, the development of science in modern Japan, etc.,[4] and part 2, which is under my charge, includes topics such as: the establishment of modern chemistry by Lavoisier, the development of atomic

theory from Dalton to Rutherford, Pasteur and spontaneous generation of life, the development of synthetic chemistry and industrial applications, the twenty century's scientific scene and its philosophical implication, etc. This course, as it appears, is not an outline course but a type of case histories. The number of students of the class often attains more than hundred and we, instructors, feel pretty heavy burdens in assigning reading materials to students and reading their reports on these topics.

There are several other examples for similar courses on the history of chemistry (or science) which are prepared in Japanese colleges and universities. I mention here names of only few of chemists who are practicing such courses in their respective institutions: Drs. T. Dono, Nagoya Technical College, H. Kashiwagi, Nagoya University, M. Tanaka, Tokyo Institute of Technology and Y. Tsuzuki, Tokyo College of Science. The last mentioned person published recently a book on the history of chemistry[5] which is characterized by its contents covering not only various aspects of the history of chemistry from ancient to modern ages but also the history of chemistry in modern Japan. A chapter on this latter subject may be considered to be an interesting case study material.

As is widely known, the development of science and technology in Japan has characteristic features in its rapidness and propagation. It is indeed a remarkable fact that in the history of science how Japan after the national isolation for a long period imported scientific and technological learning from western countries and how rapidly she assimilated and developed science and technology in the recent hundred years. In this respect I like to refer to a paper published by M. Tanaka [6] in which he critically reviews the development of chemistry in this country in the period of 1837 – 1930. He further divides this period into the following four sub-periods: the period for germination of scientific and technical learning (1837 – 1867), the period for transition from traditional to western mode of learning (1868 – 1876), the period for foundation of educational and research institutions (1877 – 1900), and the period for indpendent research in science and technology (1901 – 1930). Japan is now recognized as one of the most active five or six countries in the World in scientific and technological research. Nevertheless, I cannot avoid to notice that there is still a deep gap between modern scientific, technological cultures and our own traditional cultures. The general public

including the literary people and politicians of this country tend to evaluate science mainly from the practical point of view. Their understanding for science is rather superficial. I therefore think that it is specifically important to give both future scientists and non-scientists in this country through education some sound understanding for the historical and philosophical background of the modern science laid in western countries since the time of Galilei and Kepler.

There is another problem we are faced with in our country, that is, how we should train and educate the specialist of the history of science or chemistry. There have not been any educational facilities in our colleges or universities for that purpose, except one in the University of Tokyo which was established in 1951 as one of senior courses in the college of general education for the study of the history and philosophy of science. Students, not more than ten every year, are adopted in this course who have finished the beginning three semesters of the college. The curriculum of this special course consists of 1) basic subjects in humanities and social sciences including history and philosophy of which a certain number of credits are required; 2) basic subjects of mathematics, symbolic logic, physics, chemistry, biology and cosmology, which are treated with special reference to methodology and history, of which student elects two subjects as majors; 3) foreign languages: besides English, German, French and Russian, one of which is required; 4) seminars and research works in respective major fields. When I was in charge of this newly established course, I used in my seminar some classical works in chemistry as reading materials such as Lavoisier's *Elements of Chemistry*, Einstein's paper on Brownian motion or Staudinger's work on macromolecules, and through such materials the historical and methodological aspects of chemistry were instructed. As there has not yet been established a graduate course for this field of the history and philosophy of science, the graduates from this course have to utilize other pre-existing facilities of the same university if they wish to continue their study. Otherwise they take job, for instance, in journalism. Among the graduates there are some excellent science journalists who are on active service.

Let me lastly mention some activities of Japanese academic societies relating the study of the history of chemistry. The Japan Academy has been publishing volumes on the history of science in Japan, one volume of which deals with the

history of physical science and includes chapters on the history of chemistry in this country before and after the restoration of Meiji (1868). The Chemical Society of Japan, established in 1878, has at present several publications, among which two journals, *Kagaku to Kogyo* (Chemistry and Industry) and *Kagaku Kyoiku* (Chemical Education) include occasionally historical articles which may serve to arouse interest of professional chemists and teachers for the history of chemistry. The publishing committee of this society has edited a monograph series on chemical topics for young students, in which a volume on the history of chemical discoveries is added. The History of Science Society of Japan established in 1941 publishes now two journals: *Kagakusi Kenkyu* (Journal of history of science, Japan, quarterly) and *Japanese Studies in the History of Science* (in European languages, once a year, since 1962). In these journals one can find original papers, short notes, resourse papers, book reviews concerning the history of science. In the last mentioned journal, besides the paper by Tanaka above referred to, there is an article entitled "On the studies of history of chemistry in Japan" contributed by Tsuzuki and his collaborator[7] which deals with a brief but excellent survey of the papers on the history of chemistry appeared in this country in these twenty-five years.

In Japan there are at present only few scholars who are actually specializing in the study of the history of chemistry but there are pretty many chemists and chemistry teachers who are more or less interested in this subject. These people's recognition for the importance of the history of chemistry with respect to education is now remarkably increasing. It is therefore expected that this symposium on teaching the history of chemistry organized on an international scale by the Division of History of Chemistry in the American Chemical Society will certainly give Japanese chemists and chemistry teachers great interest and stimulation.

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