

PROBLEMS OF CONTINUITY, FLEXIBILITY AND VERSATILITY OF UNIVERSITY CHEMICAL EDUCATION*

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(Written abstract)

The rapid rate of development of chemistry and its ever-increasing role in the economy of the country have made the teaching of chemistry, as well as that of many other natural sciences, more and more difficult. The revision of teaching plans to provide the students with as much useful information as possible is an incorrect and outdated way of facing the problem. It is necessary to increase the effectiveness of useful action at university education level, to improve the quality of the education of science graduates, and to look for new ways of solving this problem. Methodological work is acquiring an ever-increasing importance.

The work necessary for the development and improvement of university chemical education varies from country to country. The problem is often solved in different ways even in universities of the same country. Therefore, a large exchange of experience in this field must be judged as very useful.

In this report we have tried to elucidate some aspects of university chemical education in the U.S.S.R., especially following the example of the Department of Chemistry of the Moscow State University 'M.V. Lomonosov', one of the biggest universities of the country. In explaining the material, the author has tried not to be one-sided, though the scientific and pedagogical activity closest to him is that of organic chemistry.

GENERAL PRINCIPLES

The Department of Chemistry of Moscow University, like many other universities of the Soviet Union, is engaged in the training of chemistry researchers and scientific workers for academic institutes, applied chemistry institutes, and chemistry laboratories of industries, as well as teachers for universities and technical chemistry institutes.

In our opinion, the scope of our universities is that of training chemists with a broad education, who must have a sound theoretical background (mathematics, physics, chemistry). Moreover, they must have a good knowledge of foreign languages and of some social disciplines. During university training it is necessary to develop in the young student the ability to approach creatively those problems which he may come across. He must have a deep knowledge of the most modern methods of physicochemical research and know how to apply them. It is also

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necessary for the student to master anything connected with that field of chemistry in which he will have to major and to have a clear view of its possible developments.

CONTINUITY

One of the most important problems, in any country, is the continuity between high school and university education. In the U.S.S.R. admission examinations to the university are based completely on the programmes carried out in high school, which formally guarantees the continuity of education. Nevertheless, this is not sufficient.

The main duty of a university teacher is that of combining his educational activity with his scientific research work. But the Department of Chemistry is deeply interested in accepting among students those who are not only well prepared in mathematics, physics and chemistry (preparation which can be checked by the admission examinations), but those who love chemistry and have made a conscious choice of their future specialization. Not all good pupils become excellent students and not all excellent students become really good research workers. As a consequence, teachers in chemistry departments have, besides their main duties, other indirect but not less important ones, like that of giving help to the secondary school. In our country, as well as in others, the preliminary orientation in the choice of the future specialization has an enormous importance. Therefore, teachers, postgraduates, and students of chemistry must actively participate in a series of initiatives to encourage the interest in chemistry and to deepen chemical knowledge in students of secondary schools. This is a kind of work which is carried out by students and postgraduates in schools and in departments of chemistry. They also organize contests, like the so-called 'olympic games' for pupils, among the pupils of a town, of a region, or of the whole country they prepare and deliver series of lectures in chemistry for pupils. Other actions aiming at the same ends are as follows: the participation of pupils in the organization of the sections *The young Chemist*, a division of the Mendeleev (All Union) Chemical Society; the annual 'open days' to university departments; the organization of courses of training for those leaving high school coming from remote places where, unfortunately, the teaching of chemistry is worse than in the cities. The result of all these initiatives is to discover the most capable pupils who are clearly keen on chemistry, some of whom may become brilliant and talented chemists.

The basic subjects for entry to a chemistry department are mathematics, physics and chemistry. The majority of those leaving high school fail their admission examinations because of lack of mathematical knowledge. In examining a student, it is particularly important to evaluate his inclination to his future profession.

The high quality of registered students is of great value but does not guarantee their future success. During their first and second years students have to face difficulties caused by their switching to a new system of education; they are asked to carry out independent work and, unlike education in school, there is no daily control of their progress. Some years ago, there was a high percentage of expelled students in the first year who failed their examination.

The following steps should be taken to improve the present educational system: to take into consideration the time used by the student for working on his own on different subjects, to eliminate a student's overload, to work out a rhythm of study, to control periodically a student's preparation by oral examinations and written tests, to draw diagrams of work, to coordinate examinations and colloquia in different disciplines in order to avoid overlapping. Of considerable importance is the participation, together with their teachers, of the representatives of student organizations in all problems related to educational matters, like attending lectures, seminars and laboratory courses, choosing courses, and raising the students' standard. The results of planning students' independent work during their first years have brought an increase in proficiency and in the quality of their preparation.

FLEXIBILITY

As in other Superior Educational Institutions of the U.S.S.R., in chemistry departments educational plans and programmes are rigid. Three and a half years are devoted to basic training, which is the same for all students, and the last year and a half to specialization. Examination sessions take place twice a year, in January and in June. Programmes and plans are periodically renewed and improved as a consequence of constant methodical work. For the student the importance of working on his own increases from year to year. If a student normally gets high marks in seminars and in laboratory courses, his examination marks may be calculated on the basis of his current proficiency.

New plans, especially to provide links with different sciences, are being elaborated for new special branches of study. In the last few years there has been a considerable increase in physical-mathematical preparation. A few years ago in the Department of Chemistry of Moscow University an experiment for the rearrangement of two basic disciplines was brought about: now, physical chemistry is taught before organic chemistry, which has given the possibility of rearranging the theoretical and practical courses of organic chemistry, of largely introducing physicochemical methods, and of instructing anew the teachers of the Chemistry Department. For the last seven or eight years, a special group of students (about ten per cent of all the course) has been created. The students belonging to such groups are trained to become specialists with a theoretical knowledge deeper than the one normally required. To this aim, their laboratory courses are reduced by half but, on the other hand, their preparation in all branches of physical chemistry is increased.

For the training of the young chemist it is very important to make him fascinated by creative research work. In order to encourage and develop independent creative work, the following initiatives play an appropriate role: research problems, free participation of students in the Student Society, recruiting the best students of the first years to give their scientific contributions to the Department, the organization of contests for the best student research work of the year, scientific lectures given by the students, and so on. A special role is played by the graduation thesis, the work for

which is carried out during the last year. The thesis is the result of a serious scientific research; in 80 to 90 per cent of cases the results obtained are published in chemical journals. The student's education is concluded by the public discussion of the graduation thesis before a State examining commission.

VERSATILITY

A peculiar characteristic of universities and their chemistry departments is that of combining scientific and teaching activities. In this connection, particularly important is the availability of special chairs in specialized activities. The large freedom in the choice of scientific subjects in universities, unlike in scientific research institutes, gives many possibilities for the student to choose his particular field of specialization.

About thirty years ago, the number of young chemists attending conferences and congresses was very small, but nowadays our young specialists are no longer guests or spectators, but main speakers. In the last few years the number of postgraduates enrolled in chemistry departments in most important universities of the U.S.S.R. has considerably increased, thus multiplying the potentialities of scientific research work.

Before 1939, the highest doctor's degree in our country, a doctorate in chemistry, was obtained at the age of 40 to 50 years, usually after the discussion of the doctor's dissertation. Nowadays, we have many doctors of science who are less than 35.

The presence in chemistry departments of many talented young people makes it necessary to have numerous special courses, both compulsory and optional. This, in turn, improves the quality and the versatility of those who are to leave university.

In chemical education it is of primary importance to master experimental techniques. Therefore it is possible to provide the latest equipment not only in scientific laboratories, but also in students' laboratories.

In conclusion, we may say that in order to improve the quality of chemistry graduates it is essential for universities to give their active cooperation to secondary schools, to choose very carefully those who want to enter a chemistry department, to carry out systematic and methodical work for the improvement of education, and to provide good and up-to-date equipment in the laboratories.