

THE PRESENT STATUS OF CHEMICAL EDUCATION IN ITALY

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On offering this country as host to the first International Symposium on University Chemical Education the group of us who urged this initiative did not imply that chemical education is a particularly well developed science in Italy. The meaning of this invitation is a more modest, but genuine, one: it is simply our deep interest in the subject. It is therefore highly rewarding to see how many colleagues from other countries have accepted with enthusiasm the invitation to meet here and tell us about their own experiences and lines of thought in chemical education.

It seems obvious that our colleagues may wish to learn something of what is going on in this country in the field of chemical education. In the following I have tried to meet this expectation in a critical way. However, my aim is substantially informative with the view that the educational status of a given country, whether satisfactory or not, *is not a purely internal affair*.

Italy is a fast growing country and experiences dramatic contrasts. In chemical education there is a contrast between the university basic teaching system and research.

(a) Basic teaching system

University education is controlled by the State in a highly centralized system: chemistry is no exception. Chemistry curricula are established by law, with little flexibility and characterization from one university to another.

Italian universities can offer only one type of degree, the *laurea*. Such a degree is obtained through 4- to 6-year programmes, each of which is substantially based on a set of compulsory courses and an additional number of optional courses. Each programme includes work for the dissertation of a thesis which can be either a report on a given subject or, in some cases, a piece of original research.

Chemistry programmes have a duration of five years. There are two such programmes, the one leading to the *laurea* of Chemistry and the other to the *laurea* of Industrial Chemistry, as reported in sections (b) and (c).

There are no admission regulations to enter the university, except for a high school diploma of some kind. Also, there is no limitation on the number of students enrolling in a given university. As a consequence, no mechanism of university planning is linked to 'saturation' values with respect to student population. The University of Rome was built in 1939 for 12000 students. Today we have more than 75000 students. This growth is easily predicted

by diagrams, but basic deficiencies in the out-dated Italian administration system have prevented a prompt solution of overcrowding problems. For example, there is no technical office for the planning of universities as might be expected for a State system controlling all universities in the country.

Lecture courses run through a non-split academic year. Each course, as characterized by a given title, is given an identical weight, i.e. it must be taught for three hours a week from about 15 November to about 20 May, and it involves a total of about 60 45-minute lectures. Also, all these lectures must be taught by the same teacher who receives a specific State appointment, whether under a tenure or a non-tenure condition. Thus, *the University can neither internally decide the duration of the diverse courses, depending on their content, nor the distribution of the teaching tasks among the staff members according to actual needs.*

It is difficult through this system to try new approaches to the teaching of chemistry, especially those based on the less traditional, more inter-disciplinary approach.

The law requires that the examinations be oral. Written tests can also be used, but since they must be followed by an oral examination anyway, it has become customary in most cases to omit written papers for the students. This is also due to the fact that an oral examination is a *very time-consuming procedure* and, therefore, any extra work must be kept to a minimum.

(b) The laurea of chemistry (University of Rome)

The 23 compulsory courses for obtaining this *laurea* are given in *Table 1*. The plan is identical in all Italian universities, except for very minor differences in the distribution of the courses among the five years and in the spectrum of the optional courses offered.

Substantial changes are banned by law. For example, it is not possible to start the teaching of physical chemistry in the first two years of the programme, and therefore to bring up-to-date the teaching of inorganic as well as organic chemistry.

(c) The laurea of industrial chemistry

The 5-year programme for this degree is similar to that for pure chemistry. A main difference is the inclusion of industrial chemistry, technology, and economics as additional compulsory courses. An industry-minded thesis is also usual.

(d) Graduate work and further research activities

The recipient of a *laurea in chimica* is also called *dottore in chimica*. There is an unfortunate coincidence of terms with different meanings between the only existing Italian degree and the doctor's degrees available in most countries. The *laurea* is *not* a doctor's degree because it involves little advanced course work and does not necessarily require any research training (no effective referee mechanism is required when original work is done).

Nevertheless, a fair amount of publishable research work is carried out by students in several laboratories. But this practice is left to the individual research groups and to the personal interest of the student and teacher.

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Table 1. *Laurea* of chemistry (University of Rome)

<i>Compulse courses</i>	<i>Optional courses</i>
<i>First Year.</i>	
Mathematics 1	no courses
Mathematics (Problems) 1	
Physics 1	
General and Inorganic Chemistry 1	
Chemistry Laboratory	
Drawing	
<i>Second Year</i>	
Mathematics 2	no courses
Mathematics (Problems) 2	
Physics	
Physics Laboratory	
General and Inorganic Chemistry 2	
Organic Chemistry 1	
Inorganic Analysis Laboratory	
<i>Third Year</i>	
Organic Chemistry 2	1 optional course out of list
Analytical Chemistry	reported below
Quantitative Analysis Laboratory	
Physical Chemistry 1	
Physical Chemistry Laboratory 1	
Mineralogy	
<i>Fourth Year</i>	
Physical Chemistry 2	4 optional courses out of the
Physical Chemistry Laboratory 2	list reported below
Organic Chemistry Laboratory	
<i>Fifth Year</i>	
Organic Syntheses	2 optional courses out of the
or Applied Analytical Chemistry Laboratory	list reported below
<i>Optional courses (requirements: 7 courses)</i>	
The following is a list of recommended optional courses:	
Instrumental Analysis (electrochemical)	
Advanced Organic Chemistry	
Theoretical Chemistry	
Advanced Mathematics	
Electrochemistry	
Organic Reaction Mechanisms	
Spectroscopy	
Inorganic Stereochemistry	
Organic Stereochemistry	
Structural Chemistry	
Chemistry of Natural Compounds	
Quantum Chemistry	
The following are additional optional courses:	
Instrumental Analysis (radiochemical). Instrumental Analysis (optical). Instrumental Analysis (chromatography). Mathematics 1, 2 and 3. Classical Mechanics. Applied Chemistry. Explosives. Macromolecular Chemistry. Electric Measurements. Radiochemistry. Spectroscopy (radio). Agricultural Chemistry. Biological Chemistry. Clinical Analysis. Food Chemistry. Applied Enzyme Chemistry. Dye-stuff Chemistry. Pharmaceutical Chemistry. Industrial Organic Chemistry. Goods Testing. Industrial Chemistry. Nuclear Chemistry. Advanced Physics. Technology. Geological Chemistry. Metallurgy.	

In the years 1963 to 1965 a number of professors of chemistry collaborated to prepare the outline of a doctoral programme in chemical sciences to serve as a basis for a Bill to be presented in Parliament. When they finished their work these people were unable to find anyone wishing to support their effort in the Government. The claim was that since the Government was planning a general reform, it would be better not to be so impatient. However, in 1969 a general reform has not yet come.

In the absence of doctoral programmes, research training is done outside formal academic courses. Research opportunities are available to young graduates in several ways (Fellowships, State assistantships, non-tenure professorships). According to a long-established Italian tradition, people who become associated with university activities eventually aim at the *Libera Docenza*, an academic title for a university teaching qualification. This is a primary stimulus for Italian graduates to acquire a considerable amount of research and teaching experience over a period of five to ten years.

Despite the out-dated educational system briefly described above, several research groups have carried out outstanding research in Italy since the 1939–45 war. In my opinion, this is due to the combination of the following main factors:

- (1) The existence of a certain layer in any society consisting of people having self-teaching abilities.
- (2) The very acute need of many young Italians to meet the scientific world outside their country after the 1939–45 war.
- (3) The efforts of the Italian Research Council (C.N.R., Rome) to support university fundamental research.

Obviously, the increasing demand of research-trained people by the growing Italian chemical industry and by the increasing university chemistry student population cannot rely on the output based only on these factors. Academic doctoral programmes are badly needed.

(e) Italian University reform: a process with a high energy of activation

Although today it would be hardly possible to find anyone among teaching staff who does not recognize the necessity of changes in chemical education, only very minor changes have actually been carried out so far. The problem is a very difficult one essentially because of the centralized structure of the whole university system.

Take for example a few operational changes such as:

- (1) Increased flexibility in chemistry curricula.
- (2) Increased flexibility in teaching load distribution.
- (3) Introduction of a two- or three-degree system, particularly the addition of doctoral programmes.

None of these changes can be effected unless several laws are modified through a long political procedure. Moreover, such laws do not always refer to chemical education alone but to the university educational system as a whole. Thus, while change (1) involves the five-year programme for the *laurea* of chemistry, change (2) involves the general regulations of the duties of the teachers as State employees and change (3) would require a compulsory change for *all* the fields of study of all universities.

What are the hopes for a change in the future? In the last 100 years Italy has had three university reforms (Casati, Gentile, De Vecchi). Since 1945, the Italian Government has been engaged for several years in another reform. In fact, from time to time several projects have been proposed by the Government, the last of which is being discussed in Parliament at the

present time. This project has been prepared by political experts, most of whom are little known by university people. *It lacks international perspectives and contains several gross mistakes* which could have been easily avoided if experts of university education, both inside and outside the country, had been consulted.

Our universities certainly need political assistance with regard to university planning and for social and financial assistance to deserving students, but they also need freedom with regard to internal organization and the development of new teaching methods.

DISCUSSION

G. S. Hammond (*California Institute of Technology*)—I believe that the Italian system as described by Professor Illuminati is the ultimate example of paternalism in the educational system. If there is any common component in the worldwide student unrest, it is a protest against paternalism. I believe that we need freedom to find new and better ways of teaching and learning, and can think of nothing more inhibitory than to require that innovation must subvert the intent of the law of the land.

H. Zollinger (*ETH, Zürich*)—Any nationally centralized organization which is responsible for university curricula inhibits new solutions and improvements. As an experimental chemist, one has, I think correctly, to apply the experimental approach also to educational problems; this means that one school of chemistry should be able and allowed to start, on an experimental basis, a new curriculum, new teaching methods, etc., without asking first a national organization, the government or similar institutions for permission.

It would be easier also to get agreement on changes proposed at a single school of chemistry level than on a broader level.

P. Strohal (*University of Zagreb*)—The problem discussed by Professor Illuminati does not deal only with the present situation of chemical education at the Italian universities. In my opinion many remarks pointed out in the paper may easily be applied to several other European countries, including Yugoslavia. Therefore, these problems must be understood soon by responsible officials, solved quickly and with special care.

M. Oki (*University of Tokyo*)—I think it is a pity that titles and durations of courses in chemistry curricula are determined by law at the university level in Italy. Since one feature of education is supposed to be diversity, the ideal education should be given to the respective student according to his character, and I would say that the Italian situation is unfortunate.

J. W. Linnett (*University of Cambridge*)—I feel that central control of courses by a national organization is wrong because it prevents experimentation in course content and pattern and reduces the variety that can occur.

However, the limitation that the system existing in Italy will cause will be greatly dependent on the way in which the students are examined. If two examinations in a given university are entirely controlled by that university, the limitation resulting from central control will be very small and perhaps

even negligible. If the examinations are externally applied the limitation will be extremely serious.

My question is therefore: are the examinations in Italy conducted separately by each university or are they centrally controlled?

C. C. Addison (*University of Nottingham*)—In my university, as in many English universities, we have recently conducted surveys on examination assessment methods, in which students themselves take part. Many examination methods have been proposed, but the extensive use of oral examinations did *not* appear to win favour with students. I was therefore very interested to learn of the almost exclusive use of oral examinations in Italy and would doubt whether this method was satisfactory.

A. R. Katritzky (*University of East Anglia*)—What is the attitude of chemical industry in Italy? Is it possible for industry to bring pressure to bear in order to effect a change in the system?

N. N. Greenwood (*University of Newcastle upon Tyne*)—To avoid any misunderstanding it might be worthwhile defining what an external examiner does in the U.K. The term is used in two senses. In the first sense (as typified by the examinations of the Royal Institute of Chemistry for professional qualifications) the examinations are set and marked on a national scale by examiners who are external to the students, i.e. they have not been involved as instructors in the students' courses. However, in the second sense, as used in British universities, the term implies something quite different. Here the examinations are in nearly all cases set and marked by the lecturers and professors who have given the lecture courses. The function of the external examiner is that of a moderator or students' friend—he comments on the working of the questions and the overall balance of the paper but he neither sets the papers nor marks them. After the examination he consults with the internal examiners, interviews certain students who are on the borderlines between the various classes of degree, and thus ensures a parity of standards between the various universities. External examiners are normally appointed for a period of three years so that, over the years, there is a substantial degree of interchange between universities.

Professor Illuminati and other Italian representatives agreed with the soundness of the criticisms and replied to some of the questions and comments as follows:

- (a) Although there is complete freedom to teach a course in any manner the teacher wishes, it is difficult for Italian professors within a rigid system to coordinate their teaching with one another and therefore the content and approach of traditional courses tends to become stereotyped.
- (b) The equivalence of standards is only formal, rather than real, since it relies on an anonymous bureaucratic centralization of major university operations, which include the establishment of curricula by law and the recruiting of professors.

THE PRESENT STATUS OF CHEMICAL EDUCATION IN ITALY

- (c) There is no relevant pressure from chemical industry. Industry is aware of the different standards from different universities. The big industrial concerns are able to cream off the best students but the smaller firms have to accept mediocre students.