Chemistry Courses in France in the Mid-Eighteenth-Century: Tradition and Innovation[1]

*Christine Lehman**

Chemistry was fashionable in the Enlightenment. In Paris, in the middle of the 18th century, the supply of chemistry courses was extensive and the public had a choice between two types: public courses, free and open to all, for instance those at the *Jardin des Apothicaires* and at the *Jardin du Roi* and fee-paying particular courses, which took place in the private laboratory of an apothecary. The teachers were either an apothecary alone, or a duo of a medical doctor as professor and an apothecary as demonstrator, or in the case of the *Jardin des Apothicaires* a group of apothecaries.[2]

These courses addressed in priority physicians and apothecaries. However, in practice, their public was much wider, chemistry also attracted philosophers, craftsmen, bourgeois and… women of quality. In Paris, more than six hundred people attended Rouelle's lectures at the *Jardin du Roi* and a hundred at the *Jardin des Apothicaires,* without taking into account the many auditors of private courses: for example, more than fifty at the one given by Macquer and Baumé. In the provinces large numbers also attended courses, the amphitheatre of the Faculty of medicine of Montpellier could contain "up to four hundred students". Is it possible to explain such a success?

What was the chemistry taught in France in the middle of the 18th century?

Was it a collection of empirical recipes? Was it a series of spectacular effects or a theoretical framework based on experimental evidence? Was it the entertainment aspect, as extolled by the course advertisements that attracted audiences? Indeed, chemistry courses were not free of theory.[3]

One cannot speak in general of the experiments proposed in a course as they were different in each type of course. They depended on the type of audience they were

* University of Paris X. Home address: 7 rue Béranger 75003 Paris. *christine.lehman@wanadoo.fr*

aimed at, on the course objectives and on the didactic choice adopted by each teacher. Rouelle's course at the *Jardin du Roi* was an experimental and applied chemistry course. In front of his extensive and heterogeneous Parisian public, Rouelle demonstrated the spectacular aspects and the applications of chemistry.[4] On the other hand, in Montpellier, Venel gave his private course in front of a smaller number of students, in the limited space of apothecary Montet's laboratory. He delivered knowledge of nature, and how to gain practical know-how.

It was an experimental chemistry: What were the functions of experiments?

Three main functions of experiments can be seen. First, transmission of practical know-how, secondly, improvement of knowledge of nature and third, illustration of chemical theory.

Know-how transmission was the objective that guided the experimental demonstrations of chemistry courses. The teacher dealt with theory and the demonstrator recapitulated the same subject, detailing the operation, and teaching the way to carry it out and the risks encountered in the operation. The demonstrator was in charge of the discourse about detailed operations, and his description also included safety recommendations.

The need to be able to reproduce experiments explains the precision found in student's notes: reactive quantities, the heat of the fire, observations such as colour changes, gas releases etc. were detailed. One had to learn "to do". Venel therefore encouraged his students to manipulate, because, in order to master the operational techniques, they had to "educate themselves in the habit of executing them". Watching operations while listening to explanations was a way to obtain know-how, even though it was clearly accepted that only a long practice could really educate the "artist".

The main function of experiments was to improve students' knowledge, and each teacher developed the subjects he knew the best, reflecting either his work or his particular interests. Beyond the pedagogical purpose, operations not only aimed at showing the components of the analysed body, but also at validating the results of the analysis by recomposition starting from the same components. Chemistry courses contributed to the progress of knowledge by stabilising facts.

Whatever the public, the courses also included experiments meant to illustrate chemical theory, such as the theory of affinities, or to reveal the elements, i.e. Air, Water, Earth and Phlogiston, which constituted natural substances. In his lectures, Macquer demonstrated the physical properties of air and its role in combustion. Rouelle and Venel proved that air was contained in oak wood and in animal substances such as blood. We do not know whether Rouelle or Venel performed experiments within their lectures on fire. But the list of the equipment used in Macquer's course at the *Jardin du Roi* does show that experiments were performed to illustrate the various properties of fire: either those of fire as an instrument and the way to produce it, or those showing the presence of the element Phlogiston. For example, the friction of two hard bodies such as a stone and a steel piece showed the Phlogiston contained in the latter, indicating that experiments were performed to illustrate a concept as theoretical as Phlogiston.

It was a theoretical chemistry

Rouelle's and Venel's chemistry courses disseminated several different kinds of theory.

First, a "technical" theory, rarely mentioned. For example, the circulation process through the fire-place of the air necessary for combustion. Venel's theoretical explanation was based on physical properties of hot air. Second, a theory of matter organised in elements, mixt and aggregates, borrowed from Becher and Stahl. And lastly, an interpretative theory of operations by means of Phlogiston and affinities.

However the theory that framed the whole chemistry course was the affinity theory, based on the use of Geoffroy's table.[5] Geoffroy's table was present in the laboratory of the *Jardin des Apothicaires*. It has been found as a draft slipped between the pages of a student's course notes, or as a printed copy glued at the last page of another student's notes. This suggests that printed tables were on sale in bookshops. Venel's students, such as Balme, carefully copied it. Generally, it was Geoffroy's table that was selected as a model. Its omnipresence in manuscript course notes confirms its current use as a tool for interpreting chemical operations. Venel expressed the affinity relations between substances as follows: "So when a simple body applied to a compound body loads itself with one of its parts and precipitates the other, one says that it has more affinity with this dissolved part than it had with the precipitated part".[6]

In order to illustrate affinities, Venel selected the example of the various affinities of nitrous acid. Venel methodically demonstrated step by step the predominance of the affinity of the column head with any substance of the column, over its affinity with the substance located immediately lower. Recourse to the affinity table was always present in Venel's chemistry course. The table was consulted to validate the preparation process of a substance (acid, alkali or salt), and the purification of metals. It was recurrently referred to in lectures on "*halotechnie*" and on the mineral kingdom.

The affinity table also made it possible to predict precipitations which were "of an immense use in chemistry". As a matter of fact it was customary to obtain substances by successive "precipitations", which could be in the form of either a solid deposit or a gas release.

However the affinity table was also often challenged and sometimes contradicted. For example, the preparation of the corrosive *sublimate* by the direct action of mercury on marine salt was surprising: "This is quite singular and gives a terrific "*soufflet"* to M^r^ Geoffroy's affinity table as the affinity of acids is quite higher with the alkalis than with metallic substances".[7] Indeed this preparation contradicts the ranking of the first column. Marine salt (sodium chloride), which results from the union of an acid with a fixed alkali, should never be attacked by mercury located at the bottom.

These few examples taken from Venel's course reveal that, thanks to this table, a chemist changed his method; he did not work blindly but could anticipate and justify his experiments. In the 18th century, Geoffroy's table was essential in both the teaching and practice of chemistry. It constituted both the frame of the course and a guide for the experimental work. It was a conceptual tool, a theoretical instrument necessary for understanding chemical knowledge just like the glassware, vessels and furnaces used to perform experiments.

Affinities, based on attractive forces of Newtonian inspiration, challenge the view of Rouelle and Venel as "Stahlian chemists". More generally, the chemistry taught by the teachers Rouelle, Venel and Macquer was neither Stalhian nor Newtonian. It was an entirely new, paradigmatic chemistry, based on experiments and supported by the theory of affinities.

As a conclusion…

Each course depended on its public: medical doctors and apothecaries who wanted to know chemistry so as to better prescribe and prepare drugs; philosophers who wanted to progress in their thinking on matter; landowners interested in the natural resources of their land; craftsmen who wanted to know about the chemistry of colours, glass, metallurgy… or, the curious, the strollers who wanted to attend the show, and… ladies of quality.

It is this convergence of interests, and a few great teachers' pedagogy and enthusiasm, which allows us to understand the infatuation with chemistry in the middle of the Enlightenment. It is this chemistry, taught and thus actually practised, this new chemistry, characteristic of the middle of the Enlightenment in France, that reformers of the end of the 18th century used as their starting point.

Notes

[1] A more complete version is to be published together with the other contributions to the Special Session: Chemistry Courses and the Construction of Chemistry, 1750-1820, in a forthcoming special issue of *Ambix*.

[2] Bernadette Bensaude-Vincent, Christine Lehman, "Between Commerce and Philanthropy: Chemistry Courses in Eighteenth-Century France," in *Science & Spectacle in Enlightenment*, eds. Bernadette Bensaude-Vincent and Christine Blondel (London: Ashgate, forthcoming). Christine Lehman, *Gabriel-François Venel (1723-1775). Sa place dans la chimie française du XVIII^e siècle* PhD Université Paris X-Nanterre, 2006 (Lille: ANRT, 2008).

[3] Bernadette Bensaude-Vincent, Christine Lehman, "Public Lectures in Mid-Eighteenth Century France," in *New Narratives in Eighteenth Century Chemistry*, ed. Lawrence M. Principe (Dordrecht: Springer, 2007), 77-96.

[4] Lissa Roberts, "Chemistry on stage: G.F. Rouelle and the theatricality of Eighteenth-Century Chemistry," in *Science & Spectacle in Enlightenment*, eds. Bernadette Bensaude-Vincent and Christine Blondel (London: Ashgate, forthcoming).

[5] Lissa Roberts, "Setting the Tables: The Disciplinary Development of Eighteenth-Century. Chemistry as Read through the Changing Structure of its Table," *The Literary Structure of Scientific Argument. Historical Studies*, ed. Peter Dear (Philadelphia: University of Pennsylvania Press, 1991), 109-113; Ursula Klein and Wolfgang Lefèvre, *Materials in Eighteenth-Century Science. A Historical Ontology* (Cambridge MA: MIT Press, 2007).

[6] Wellcome Institute Library, London, Ms 4914 [Notebook by Balme]: «Cours de Chymie fait chez monsieur Montet apothicaire par monsieur Venel Docteur et professeur en L'université De medecine à Montpellier, 1761,» p.190.

[7] Wellcome Institute Library, London, Ms 4914, p. 149.