The Interplay of Chemical Teaching with Work and with Research: A Case Study from Germany around 1800, Johann Friedrich August Göttling at Jena

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The socio-epistemological structure of chemistry in Germany around 1800

The socio-epistemological structure of chemistry in Germany around 1800 is depicted in Fig. 1. The notion of "socio-epistemological" is the key concept being put forward in order to be able to understand the nature of chemistry in Germany around 1800.[1]

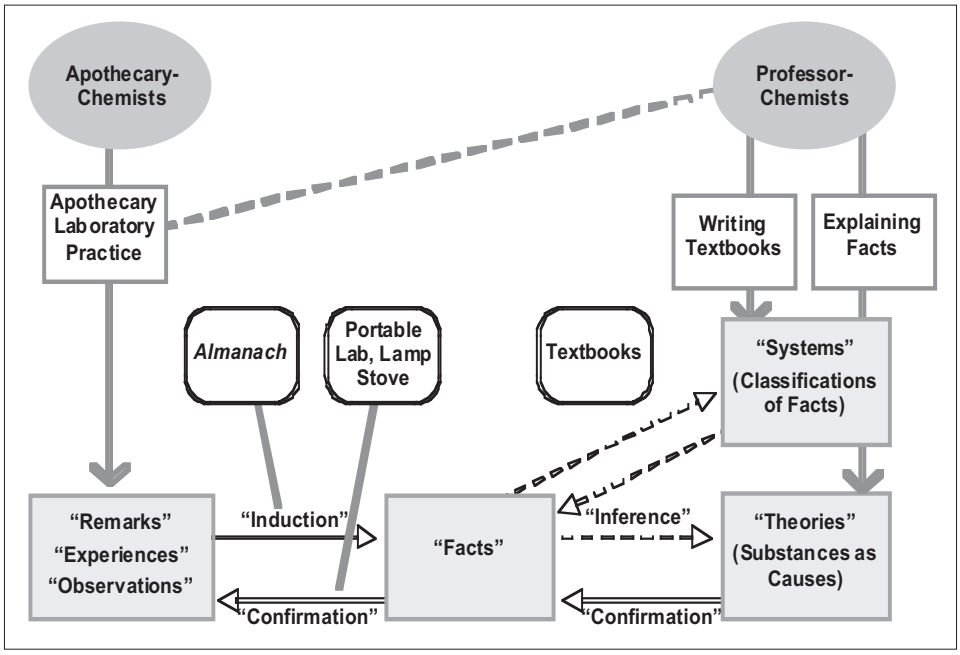

Figure 1. Socio-epistemological structure of chemistry in Germany around 1800.

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Chemistry was practised around 1800 by members of mainly two professional groups: apothecaries and university professors. Their main professional duties, respectively, were producing remedies and teaching chemical knowledge, it did not comprise chemistry as a research practice. There was hardly any institutionalised form of experimental chemistry in the sense of a well-directed pursuit of new chemical knowledge, carried out in dedicated research laboratories.

German chemists coped with this situation by using a three-level epistemology. Although this epistemology was mostly practiced without explicit discussion, at least some textbooks of chemistry explained it and presented it as the right way to do chemistry scientifically. The bottom row in Fig. 1 follows Scherer's *Versuch einer populären Chemie*.[2]

The first level of the epistemology consists of "remarks", "experiences" or "observations". These were made either in every day life or in a laboratory. By far the largest number of laboratories was part of apothecary shops, and an increasing proportion of apothecaries became interested in chemistry and communicated casual observations and remarks. They thereby became what Ursula Klein has aptly called "apothecary-chemists".[3] Journals founded in the period, such as Florenz Lorenz Friedrich Crell's *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst und Manufacturen* and, even more so, Johann Friedrich August Göttling's *Almanach oder Taschenbuch für Scheidekünstler und Apotheker* allowed a fast publication of what were sometimes minuscule observations. Although professor-chemists and other people could have provided this kind of raw material for chemical knowledge, the bulk of it came from the apothecary-chemists. In contrast, the main field of chemical research practice on the part of the professor-chemists consisted of doing something with the chemical facts. Either they interpreted the facts theoretically (mainly by tracing them to underlying reactions among different substances, including the physical substances such as the matters of heat, light, etc.) or they gathered and systemised the facts in textbooks (see below).

The epistemology's intermediate level of the chemical facts served to distance both kinds of chemical practice. Facts were seen as the epitome of chemistry: eternal, and belonging to nature rather than to some particular kind of scientific practice. In particular, making observations and remarks as apothecaries did, was regarded as not yet real chemical science. To be sure, it was the professor-chemists who invented this epistemology. Thus, socio-epistemological boundary-work was done in order to save "scientific" academic chemistry from the intrusion of practitioners from outside, whilst at the same time to allow themselves to draw

on the input from apothecaries and others, who were much better equipped in terms of laboratories and instruments than were the professors.

One instance illustrates this very clearly. In 1789, Göttling announced in his *Almanach* that from then on he would refuse to publish long, theoretical treatises, and he urged his readers to abstain from sending him this kind of texts.[4] Chemistry strongly relied on the provision of remarks by the apothecaries, but, from the point of view of the professors, these remarks did not turn them into scientific chemists.

The inclusion and transformation of remarks into scientific knowledge was no easy task. Chemists had to somehow enable the transition from observations to facts and from facts to systems and theories. This was achieved by what it is suggested to call "techniques of mediation". Göttling invented several of them; attention will be focused on two of them which are directly related to teaching.

Textbooks

Writing textbooks was one possibility to make something of the chemical facts.[5] Göttling's *Handbuch der theoretischen und praktischen Chemie* can be seen as the starting point for an independent genre, textbooks of *theoretische Chemie*.[6] Three things are remarkable with regard to this kind of textbook. First, "theoretical" did not mean something of a deeper explanation, but rather, "non-practical". Authors of textbooks of "theoretical chemistry" deliberately left out laboratory practice and confined themselves to gathering, selecting and arranging the known chemical facts, which resulted in a number of different chemical systems. Second, these textbooks were by no means didactic adaptations of systems of chemistry, elsewhere published. These textbooks were the very occasion to develop these systems in the first place.

Third, and difficult to explain, although developing ordered systems of, for example, chemical substances is without doubt a contribution to chemistry as a science (note that Mendeleev's periodic table was built in the course of writing a textbook), authors, which were exclusively university professors, couched their systems in a rhetoric of pure didactics. They bothered whether their systems were suitable for learning chemistry, but not whether or not they corresponded to nature.

This begs the questions, why several professor-chemists wrote such textbooks and did so in this particular way. Of course, writing one's own textbook was still

indispensible for academic teachers, if only for improving chances to get a salaried position, to allow the students to dispense with taking notes or to earn a part of one's living from authorship fees. However, this still that does not explain why they chose facts as the content of their textbooks, and why they restricted their own, alleged, role to *presenting* systems of facts rather than to *finding* these systems.

It is suggested that this is to be understood as part of a strategy to professionalise chemistry as a science. On the social level, this meant to claim, scientific chemistry was restricted to professor-chemists. But since these were paid exclusively for teaching, and not at that time for research, they presented their theoretical chemistry as pure didactics. On the epistemological level, this went along with the emerging separation of research and teaching. While in terms of institutions, research was integrated in the universities during the 19th century (in Germany, at least), in terms of epistemological relevance, teaching was deprived its primary role. Since then, the realm of teaching was more and more regarded as subsidiary to research. This modern view seemed to have had already spread among chemists around 1800.

Portable laboratories

The second example mediates between observations and facts. Göttling designed different portable laboratories, which contained a selection of reagents and some very simple chemical equipment.[7] These portable laboratories served several purposes for establishing chemistry as a science, apart from providing Göttling with an extra income in addition to his modest university salary.

For example, portable laboratories made the laboratory mobile. Chemical tasks such as the analysis of mineral waters could then be done without access to an apothecary laboratory. It is known that these portable laboratories were successful. On request, Göttling later offered a cheaper version containing only those reagents that were of particular use for medical analyses.

Likewise, portable laboratories provided facilities for teaching and learning. Students were enabled to learn chemistry from their own experience, outside the lecture hall. Furthermore, the portable laboratories with their sets of instructions merged tacit skills mostly found in apothecary laboratories with textual knowledge about substances usually found in university textbooks. The reagents and the recipes were standardised according to Göttling's own purity standard. Thus,

the portable laboratories provided for standardisation of chemical work *and* of chemical teaching at the same time.

The manual for the first portable laboratory was entitled *Vollständiges chemisches Probir-Cabinet zum Handgebrauche für Scheidekünstler, Aerzte, Mineralogen, Metallurgen, Technologen, Fabrikanten, Oekonomen und Naturliebhaber* (Complete chemical portable laboratory for chemists, medical doctors, mineralogists, metallurgists, technologists, factory owners, economists and amateurs). Addressing as many potential buyers as possible in the title was common practice. All the more it is telling that Göttling mentioned neither apothecaries, nor professors. Thus, the message given by these portable laboratories was clear. Everyone could learn chemistry and practice chemistry, in particular outside its two dominant institutions, the apothecary shop and the lecture hall.

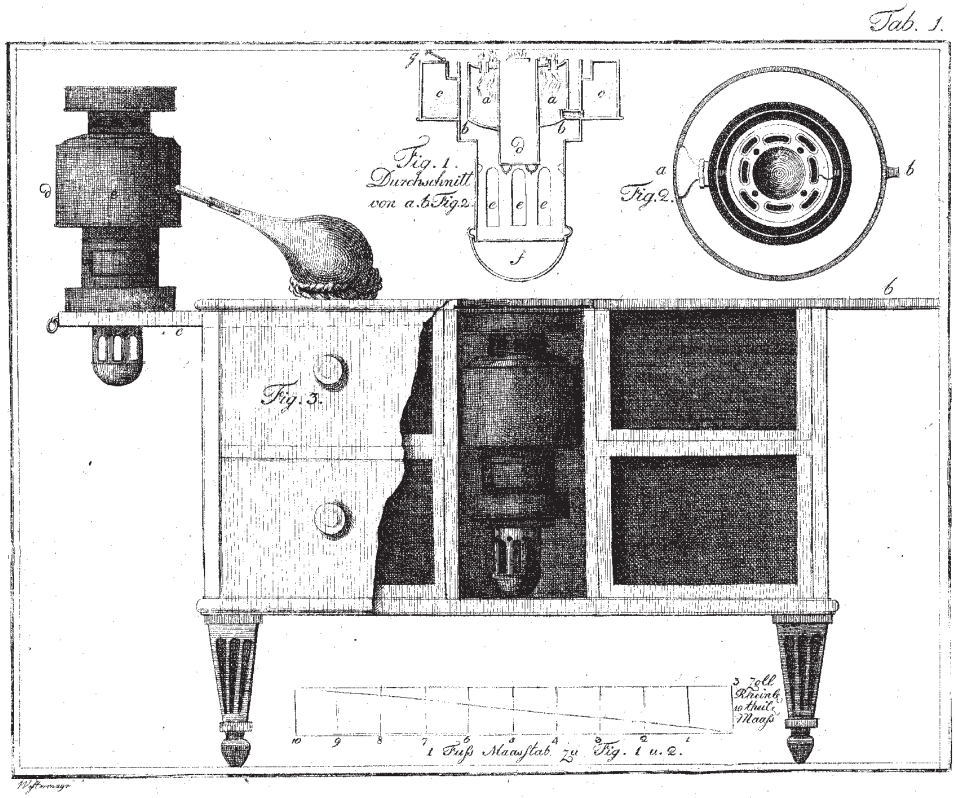

Figure 2. Cupboard with lamp-stove for students, from: *Almanach oder Taschenbuch für Scheidekünstler und Apotheker 1796.* Courtesy Thüringer Universitäts- und Landesbibliothek Jena.

In addition, Göttling invented a lamp-stove for students and even a special cupboard, which allowed turning a student's room into a chemical laboratory with a few touches. Göttling himself used the lamp-stove in his lectures, and it is most probable that the portable laboratories also served him, for bridging the distance between his laboratory and the lecture hall.

Conclusion

These are two examples of just how intimately the practice of teaching was tied to the construction of chemistry as a research science. Teaching, the core activity of the main group of chemists in Germany around 1800, was inextricably interwoven with chemistry *per se*. Nevertheless, there was also the explicit and implicit denial of any importance of teaching, uttered by the actors themselves. In the epistemology, the way back from theories via facts to observations was seen as a merely didactic "confirmation".

This discrepancy between daily practice on the one hand and the three separations (between the epistemological levels, between the social groups, and between research and teaching) on the other hand should not be ignored. In contrast, the role of these discrepancies for the formation of chemistry has to be understood.

Notes

[1] For an extended discussion of the topics of the talk and for the full set of references, see Jan Frercks, "Techniken der Vermittlung: Chemie als Verbindung von Arbeit, Lehre und Forschung am Beispiel von J. F. A. Göttling," *NTM. Journal for History of Science, Technology and Medicine*, 16 (2008), 279-308. A further paper focussing on the socio-epistemological concept of "chemical fact" is in preparation.

[2] Alexander Nicolaus Scherer, *Versuch einer populären Chemie* (Mühlhausen: Danner, 1795).

[3] Ursula Klein, "Apothecary-Chemists in Eighteenth-Century Germany," in *New Narratives in Eighteenth Century Chemistry*, ed. Lawrence M. Principe (Dordrecht: Springer, 2007), 97-137.

[4] *Almanach* 1789, pp. 176-181. Maybe not accidentally, Göttling wrote this at the moment when he had just become a professor at the University of Jena.

[5] This is explained in much more detail in Jan Frercks and Michael Markert, "The Invention of *Theoretische Chemie*. Forms and Uses of German Chemistry Textbooks, 1775–1820," *Ambix* 54 (2007): 146-171. Textbooks in general receive increasing attention since some years, see for example Bettina Haupt, *Deutschsprachige Chemielehrbücher (1775-1850)* (Stuttgart: Deutscher Apotheker Verlag, 1987), Anders Lundgren and Bernadette Bensaude-Vincent, *Communicating Chemistry: Textbooks and Their Audiences, 1789-1939*, ed. (Canton/Mass.: Science History Publications, 2000), or José Ramón Bertomeu-Sánchez, Antonio García-Belmar, and Bernadette

Bensaude-Vincent, "Looking for an Order of Things: Textbooks and Chemical Classifications in Nineteenth Century France," *Ambix* 49 (2002): 227-250.

[6] Johann Friedrich August Göttling, *Handbuch der theoretischen und praktischen Chemie*, 3 vols. (Jena: Akademische Buchhandlung, 1798-1800).

[7] On portable laboratories see William Arthur, L. B. Smeaton, "The Portable Chemical Laboratories of Guyton de Morveau, Cronstedt and Göttling," *Ambix* 13 (1966), 84-91, and Brian Gee, "Amusement Chests and Portable Laboratories: Practical Alternatives to the Regular Laboratory," in *The Development of the Laboratory*: *Essays on the Place of Experiment in Industrial Civilization*, ed. Frank A. J. L. James (Basingstoke: MacMillan Press, 1989), 37-59.