Chemistry Textbooks in the 19th Century

A Genre of Scientific Literature

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& Antonio García Belmar

Between the French Revolution and the middle of the 19th century chemistry textbooks emerged in France as an independent genre of scientific literature. The educational reforms introduced during the revolution radically transformed the teaching of science. These reforms were especially important for chemistry. Up to the end of the 18th century chemistry was taught mainly in unregulated public courses open to a mixed audience of medical and pharmaceutical students, artisans, and a public attracted by the spectacle of experimental demonstrations. After the revolution chemistry became part of the official syllabus in a number of teaching institutions: secondary schools, colleges dedicated to teacher training, schools of pharmacy and medicine, and, later, engineering schools and military academies.

These changes have been studied primarily from an institutional and social point of view. But how did the new institutional framework affect teaching content and practice? How were the methods and the didactic instruments adapted to new audiences, spaces, and teaching schedules? How were the contents of chemistry redefined and restructured so as to be taught?

We began our study of textbooks, one of the objects most representative of institutionalized teaching, in the belief that they constitute an excellent source for answering these questions. And indeed the textbook—barely distinguishable at the turn of the century from other scientific publications, such as treatises, technical handbooks, or popularizing texts—became in less than 50 years a didactic tool adapted to new teaching conditions; a distinguishable and independent genre of scientific literature in a changing book trade; and an instrument of scientific communication with specific content, form, style, audiences, and aims.

The pursuit of our study exposed the methodological assumptions behind it.

Defining *Textbook*

Chemistry textbooks emerged in the same context as other genres of scientific literature and adopted their own identity, both as editorial goods and as tools of scientific communication. The first half of the 19th century saw scientific journals, popular scientific literature, encyclopedic treatises, technical handbooks, instrument makers' catalogues, dictionaries, and many different types of publications arise in a scientific publishing market that was constantly expanding and being transformed. Textbooks coexisted, interacted, and very often confounded themselves with many of these other types of publications, sharing publics, uses, and objectives. How could we distinguish, for instance, a textbook for primary education from a popular text; or a course of general chemistry from a treatise; or even a handbook of chemical analysis or a text of chemical amusements from an instrument maker's catalogue?

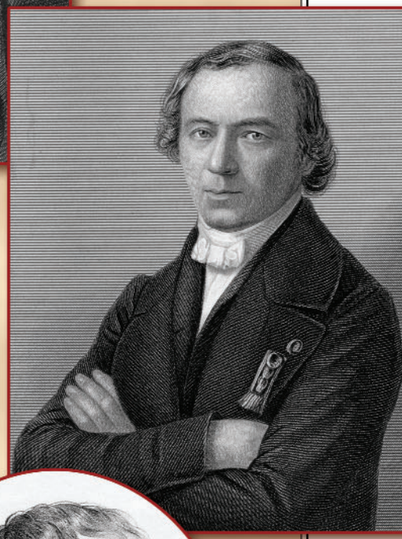
Paradoxically, the definition of chemistry textbook, originally one of the final aims of our study, became a preliminary question, as we needed first to define the object of our study. A basic distinction allowed us to escape from this cul-de-sac. Textbooks could be defined by the intention with which they were produced or by the uses to which historical actors put them. Thus a textbook can be regarded as

- any text actually used for teaching purposes, or
- any text expressly and explicitly conceived for use as a didactic tool in the framework of a particular teaching institution.

The definition based only on use would require us to examine a variety of texts not necessarily conceived of as textbooks by their authors or publishers. The definition based on intention instead pointed us toward a history of the idea of textbook as it was conceived, expressed, and made material by the various actors—authors, publishers, readers, the government, and scientists—who participated in the production of this type of texts.

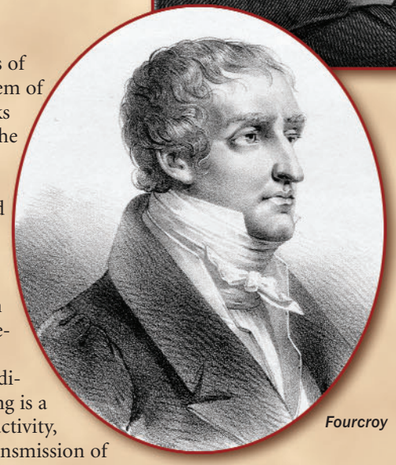
We therefore adopted the second definition in preparing our main working tool: a bibliography of 483 chemistry textbooks published in France between 1789 and 1865, all of which contain explicit evidence of their didactic purpose.

Chaptal



Dumas

Authors of textbooks from the French revolution through the restoration can be put into three groups: those who are generally well known, like Antoine-François de Fourcroy (1755–1809), Jean-Antoine de Chaptal (1756– 1832), and Jean-Baptiste Dumas (1800–1884) (all courtesy of the Edgar Fahs Smith Collection, University of Pennsylvania Library); those who are well enough known to have entries in the Dictionary of Scientific Biography, *like Louis-Jacques Thénard (1777–1857) (courtesy of the Smith Collection) and Mateu Orfila (1787–1853) (courtesy of the Dibner Collection, Smithsonian) form a second group. The third group, of "unknowns," is represented here only by images of their books.*



Fourcroy

Problems of Analysis

After defining our objects of study, we faced the problem of analyzing them. Textbooks have been missing from the historiography of science for a long time.

This absence occurred because, first, textbooks have suffered from the assumption that a clear distinction exists between the production and the reproduction of scientific knowledge. From this traditional perspective, teaching is a secondary or peripheral activity, reduced to the passive transmission of knowledge produced elsewhere.

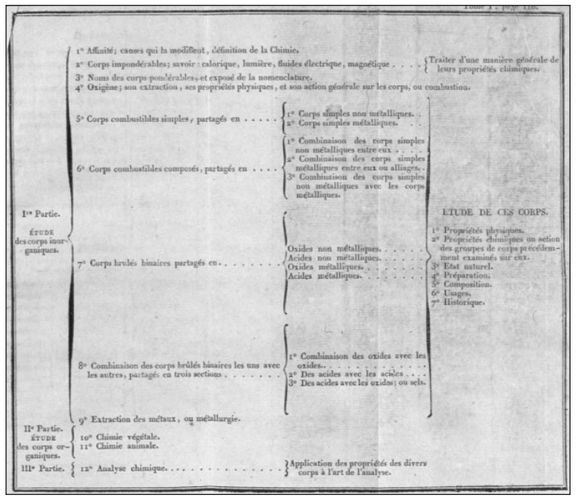
Second, historians of science have traditionally read texts as passive holders of the *authors*' ideas, overlooking the influence that other actors and factors implied in producing a text can have on the form and content of the knowledge transmitted.

Textbooks, like any scientific text, are the result of specific practices of writing and reading, as well as material objects that have to be designed, organized, manufactured, printed, sold,

Continued *on page xx*

Continued *from page xxx*

(opposite page) This page ***<Eds: or plate? Or foldout?>*** *from Louis-Jacques Thénard's* Traité de chimie élémentaire *(Paris: Crochard, 1813; vol. 1, p. 118), contains a table based on the author's famous "artificial" classification, based on reactivity with oxygen. From the Roy G. Neville Chemical Historical Library, CHF.*



1° Affinité; causes qui la modifient, définition de la Chimie.
2° Corps impondérables; savoir : calorique, lumière, fluides électrique, magnétique . . . } Traiter d'une manière générale de leurs propriétés chimiques.
3° Noms des corps pondérables, et exposé de la nomenclature.
4° Origine; son extraction, ses propriétés physiques, et son action générale sur les corps, ou combustion.

5° Corps combustibles simples, partagés en . . . . . { 1° Corps simples non métalliques. 2° Corps simples métalliques.

6° Corps combustibles composés, partagés en . . . . { 1° Combinaison des corps simples non métalliques entre eux . . . 2° Combinaison des corps simples métalliques entre eux ou alliages. 3° Combinaison des corps simples non métalliques avec les corps métalliques.

I^re^ Partie. ÉTUDE des corps inorganiques.

ETUDE DE CES CORPS.
1° Propriétés physiques.
2° Propriétés chimiques ou action des groupes de corps précédemment examinés sur eux.
3° Etat naturel.
4° Préparation.
5° Composition.
6° Usages.
7° Historique.

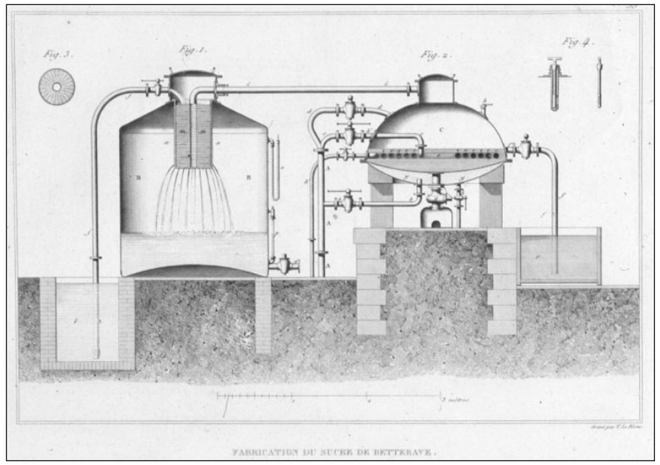
7° Corps brûlés binaires partagés en . . . . . Oxides non métalliques. . . . . Acides non métalliques. . . . . Oxides métalliques. . . . . Acides métalliques. . . . . .

8° Combinaison des corps brûlés binaires les uns avec les autres, partagés en trois sections . . . . . { 1° Combinaison des oxides avec les oxides. . . . . 2° Des acides avec les acides . . . 3° Des acides avec les oxides ou sels.

9° Extraction des métaux, ou métallurgie.

II^e^ Partie. ÉTUDE des corps organiques. { 10° Chimie végétale. 11° Chimie animale.

III^e^ Partie. { 12° Analyse chimique. . . . . } Application des propriétés des divers corps à l'art de l'analyse.



Institutions interested in the application of chemistry to arts and industry enlarged the public for chemistry books. This plate from volume 8 of Dumas's Traité de chimie, appliquée aux arts *(1828–1846), depicts chemical processes and equipment used in <Eds: ?paper-making?>. From the Roy G. Neville Chemical Historical Library, CHF.*

and finally read. First, writing a textbook usually involves tedious paperwork, gathering information and organizing it inside a general structure. The result, a manuscript, has to be printed with the available technological printing tools, which limits what can be included in the final publication. In some cases, printing techniques do not even allow authors to introduce a given image, because printing it is expensive or simply impossible.

Finally, textbooks have to be sold in a competitive market and read by students or other audiences. Students absorb the content of textbooks by reading them, and reading practices changed during the 18th and 19th centuries. Donald McKenzie, for example, has argued that intensive reading of a small number of texts was replaced by extensive reading of a large number of books.

These are some of the ideas to consider as we approach chemistry textbooks as objects shaped by economical, social, political, and scientific interests similar to those that define the teaching of science today. Thus we should examine the intended audiences of these works; their publishers; their authors; and their scientific content.

Intended Audiences

Textbooks are identified first through their target public. The contents, format, size, typographic, iconographic features, and even the authority of a given textbook's author are presented as answers to the specific capacities, formative needs, methods of learning, and the reading practices of its particular intended audience. Forewords are the space where authors and editors usually define the ideal public for which their product is conceived. This may well not be the public that actually reads the texts, but it is the public that authors and editors had in mind when they wrote, printed, and sold them. Thus a detailed study of the target public is fundamental to reconstructing its expectations and to understanding how its formative needs and its future aspirations helped shape the content and the form of chemistry textbooks.

Several important changes occurred during the period we studied. While 18th-century texts made standard references to the heterogeneous publics they intended to reach, publics now became more narrowly defined as official curricula became more organized. At the end of 18th century, authors of chemistry textbooks usually targeted two important audiences: first, pharmaceutical and medical students, that is, one of the traditional audiences of chemistry throughout the 17th century; and second, students attending lectures on physics and chemistry at the new secondary school system created during the French Revolution, the ephemeral *écoles centrals*.

During the first third of the 19th century (under the first Napoleonic empire and the Bourbon Restoration, roughly 1804–1828) chemistry almost disappeared from the curricula of secondary schools. Thanks to the reforms of Antoine François de Fourcroy, however, it consolidated its position in the three faculties of medicine at Paris, Strasbourg, and Montpellier, which included chemistry lectures and exams in their curricula. Side by side with this official instruction, young teachers in Paris offered a substantial number of private lectures on chemistry. Medical students therefore became the main intended readers of chemistry textbooks in these years.

Several changes in during the 1830s–1850s introduced chemistry textbooks to new audiences. The most important was the recovery of secondary school students as chemistry gained importance for those wishing to enter the faculties of medicine. But chemistry was also taught at military schools and at technical teaching institutions like the Conservatoire des Arts et Métiers and the schools of veterinary science. Finally, chemistry was also included in primary schools and therefore in the new normal schools for primary teachers.

The expansion and diversification of publics coincided along with the publication of a variety of chemistry textbooks specially tailored for every audience.

Publishers and the Book Market

The technical and economic changes that transformed the French book market as a whole during the first half of the 19th century also affected the production of textbooks. As historians of books have noted, textbooks played a crucial role in the growth of important publishing houses during this period. Moreover, the concentration of publishing in the hands of a small number of important Parisian publishers was equally important for the consolidation of textbooks as an independent genre. This phenomenon, common to all disciplines, included the marginal one of chemistry.

Early in the century scientific publishers were in charge of producing the first textbooks written for the new educational institutions that emerged from the French Revolution. Publishers such as Bernard or Nicolas Clochard listed in the same catalogue the great treatises and most important scientific journals such as *Annales de Chimie* next to the most popular chemistry textbooks. From the 1830s on, established publishers of scientific texts, such as Victor Masson, started to specialize, to promote textbooks more actively in their catalogues. Similarly a new publisher founded in 1826, Louis Hachette, succeeded in nearly controlling the market in textbooks for primary and secondary schools during the second half of nineteenth-century. Publishers in the provinces declined, so that those in Paris—increasingly few—dominated.

This process of centralization and specialization of textbook production was reinforced by an important change in the government's control mechanism. Rather than imposing an official textbook on courses, the government replaced it with an official syllabus that authors and editors had to respect when selecting the contents of their textbooks. This new approach introduced a margin of freedom into textbook production and placed publishers in a privileged position as mediators between readers, authors, and the government.

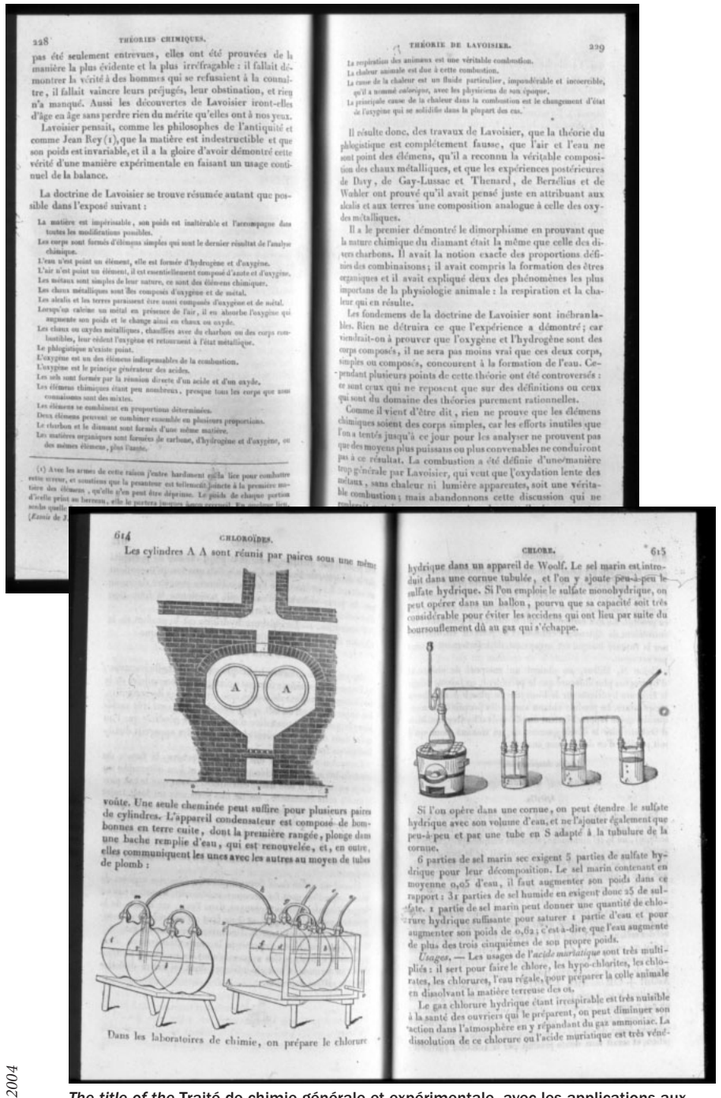
Authors

The main task of creating a textbook remained, however, in the hands of authors, who had to work within a multiplicity of constraints: textbooks had to be didactic tools—simultaneously adapted to a particular audience, acceptable to an extremely vigilant government, competitive, and attractive enough to be accepted by publishers and scientific practitioners of the time. Within these constraints, authors nonetheless had a wide range of possibilities when writing their textbooks, as the diversity of textbooks in the period studied shows.

Thénard

Who are these historical actors and what drove them to write and publish a chemistry textbook? At the end of 18th century these authors included such well-known protagonists of the chemical revolution as Chaptal, Fourcroy, and Lavoisier, whose textbooks went through several editions and whose motives in writing were no doubt prompted by their experience as active researchers. The motives of others who are less well known but not totally unstudied, including Jean-Baptiste Dumas, Louis Jacques Thénard, Mathurin Jacques Brisson, and Matheu Orfila, may be accessible. But it is rather difficult to know the motives of many obscure figures who were nonetheless the authors of the textbooks used to teach chemistry to several generations of students and future chemists. These "illustres inconnus" include Pierre Jacotot (1756–1821), Jean Baptiste Jumelin (1745–1807), Claude Lucien Bergery (1787–1863), Benjamin Boutet de Monvel (1820– post 1883), Nicolas Deguin (1809–?), Cesar

Orfila


228 THÉORIES CHIMIQUES.

pas été seulement entrevues, elles ont été prouvées de la manière la plus évidente et la plus irréfragable : il fallait démontrer la vérité à des hommes qui se refusaient à la constater, il fallait vaincre leurs préjugés, leur obstination, et rien n'a manqué. Aussi les découvertes de Lavoisier iront-elles d'âge en âge sans perdre rien du mérite qu'elles ont à nos yeux.

Lavoisier pensait, comme les philosophes de l'antiquité et comme Jean Rey (1), que la matière est indestructible et que son poids est invariable, et il a la gloire d'avoir démontré cette vérité d'une manière expérimentale en faisant un usage continuel de la balance.

La doctrine de Lavoisier se trouve résumée autant que possible dans l'exposé suivant :

La matière est impérissable, son poids est inaltérable et l'accompagne dans toutes les modifications possibles.
Les corps sont formés d'éléments simples qui sont le dernier résultat de l'analyse chimique.
L'eau n'est point un élément, elle est formée d'hydrogène et d'oxygène.
L'air n'est point un élément, il est essentiellement composé d'azote et d'oxygène.
Les métaux sont simples de leur nature, ce sont des éléments chimiques.
Les chaux métalliques sont des composés d'oxygène et de métal.
Les alcalis et les terres paraissent être aussi composés d'oxygène et de métal.
Lorsqu'un calcaire ou métal en présence de l'air, il en absorbe l'oxygène qui augmente son poids et le change ainsi en chaux ou oxyde.
Les chaux ou oxydes métalliques, chauffées avec du charbon ou des corps combustibles, leur cèdent l'oxygène et retournent à l'état métallique.
Le phlogistique n'existe point.
L'oxygène est un des éléments indispensables de la combustion.
L'oxygène est le principe générateur des acides.
Les sels sont formés par la réunion directe d'un acide et d'un oxyde.
Les éléments chimiques étant peu nombreux, presque tous les corps que nous connaissons sont des mixtes.
Les éléments se combinent en proportions déterminées.
Deux éléments peuvent se combiner ensemble en plusieurs proportions.
Le charbon et le diamant sont formés d'une même matière.
Les matières organiques sont formées de carbone, d'hydrogène et d'oxygène, ou des mêmes éléments, plus l'azote.

(1) Avec les armes de cette raison l'autre hardiment qu'ils lice pour combattre cette erreur, et soustiens que la pesanteur est tellement jointe à la première matière des éléments, qu'elle n'en peut être séparée. Le pinde de chaque portion seulis quelle

THÉORIE DE LAVOISIER. 229

La respiration des animaux est une véritable combustion.
La chaleur animale est due à cette combustion.
La cause de la chaleur est un fluide particulier, impondérable et incoercible, qu'il a nommé *calorique*, avec les physiciens de son époque.
La principale cause de la chaleur dans la combustion est le changement d'état de l'oxygène qui se solidifie dans la plupart des cas.

Il résulte donc, des travaux de Lavoisier, que la théorie du phlogistique est complétement fausse, que l'air et l'eau ne sont point des éléments, qu'il a reconnu la véritable composition des chaux métalliques, et que les expériences postérieures de Davy, de Gay-Lussac et Thenard, de Berzélius et de Wahler ont prouvé qu'il avait pensé juste en attribuant aux alcalis et aux terres une composition analogue à celle des oxydes métalliques.

Il a le premier démontré le dimorphisme en prouvant que la nature chimique du diamant était la même que celle des différens charbons. Il avait la notion exacte des proportions définies des combinaisons ; il avait compris la formation des êtres organiques et il avait expliqué deux des phénomènes les plus importans de la physiologie animale : la respiration et la chaleur qui en résulte.

Les fondemens de la doctrine de Lavoisier sont inébranlables. Rien ne détruira ce que l'expérience a démontré ; car viendrait-on à prouver que l'oxygène et l'hydrogène sont des corps composés, il ne sera pas moins vrai que ces deux corps, simples ou composés, concourent à la formation de l'eau. Cependant plusieurs points de cette théorie ont été controversés : ce sont ceux qui ne reposent que sur des définitions ou ceux qui sont du domaine des théories purement rationnelles.

Comme il vient d'être dit, rien ne prouve que les élémens chimiques soient des corps simples, car les efforts inutiles que l'on a tentés jusqu'à ce jour pour les analyser ne prouvent pas que des moyens plus puissans ou plus convenables ne conduiront pas à ce résultat. La combustion a été définie d'une manière trop générale par Lavoisier, qui veut que l'oxydation lente des métaux, sans chaleur ni lumière apparentes, soit une véritable combustion ; mais abandonnons cette discussion qui ne

614 CHLORURES.

Les cylindres A A sont réunis par paires sous une même

voûte. Une seule cheminée peut suffire pour plusieurs paires de cylindres. L'appareil condensateur est composé de bonbonnes en terre cuite, dont la première rangée, plonge dans une bache remplie d'eau, qui est renouvelée, et, en outre, elles communiquent les unes avec les autres au moyen de tubes de plomb ;

Dans les laboratoires de chimie, on prépare le chlorure

615 CHLORE.

hydrique dans un appareil de Woolf. Le sel marin est introduit dans une cornue tubulée, et l'on y ajoute peu-à-peu le sulfate hydrique. Si l'on emploie le sulfate monohydrique, on peut opérer dans un ballon, pourvu que sa capacité soit très considérable pour éviter les accidens qui ont lieu par suite du boursoufflement dû au gaz qui s'échappe.

Si l'on opère dans une cornue, on peut étendre le sulfate hydrique avec son volume d'eau, et ne l'ajouter également que peu-à-peu et par une tube en S adapté à la tubulure de la cornue.

6 parties de sel marin sec exigent 5 parties de sulfate hydrique pour leur décomposition. Le sel marin contenant en moyenne 0,05 d'eau, il faut augmenter son poids dans ce rapport : 31 parties de sel humide en exigent donc 15 de sulfate. 1 partie de sel marin peut donner une quantité de chlorure hydrique suffisante pour saturer 1 partie d'eau et pour augmenter son poids de 0,62 ; c'est-à-dire que l'eau augmente de plus des trois cinquièmes de son propre poids.

Usages. — Les usages de l'*acide muriatique* sont très multipliés : il sert pour faire le chlore, les hypo-chlorites, les chlorates, les chlorures, l'eau régale, pour préparer la colle animale en dissolvant la matière terreuse des os.

Le gaz chlorure hydrique étant irrespirable est très nuisible à la santé des ouvriers qui le préparent, on peut diminuer son action dans l'atmosphère en y répandant du gaz ammoniac. La dissolution de ce chlorure ou l'acide muriatique est très vénéfi-

The title of the Traité de chimie générale et expérimentale, avec les applications aux arts, à la médecine, et à la pharmacie *(Paris: J. B. Baillière, 1844, 1846), by Alexandre Edouard Baudrimont, (1806–1880) speaks to two important audiences of the new textbooks: medical and pharmaceutical students and applied chemists. Pages 228–229 give a summary of Lavoisier's new chemical theory. Pages 614–615 reflect the ability of textbooks publishers to insert images directly into the text from the decade of 1840 onwards, owing to new printing techniques. <Eds: Check that this is so, or we'll have to find a volume that does have inserted images.> From the Roy G. Neville Chemical Historical Library, CHF.*

Despretz (1789–1863), Alphonse Dupasquier (1793–1848), and Rodolphe Kaeppelin (1810–1871), who wrote for secondary and primary schools.

We can nonetheless summarize some changing trends in the biographical profile of chemistry textbook authors during the periods under study here.

The first period (1789–1800) included not only the protagonists of the chemical revolution but also a small but relevant group of teachers at the new secondary schools, among them Brisson, Jacotot, and Jumelin. All were deeply involved in revolutionary educational reforms and supported the new educational system in part by publishing textbooks.

The elimination of chemistry courses from secondary schools through 1800–1831 reduced the participation of secondary teachers in textbook production. We found two main groups of authors: apothecaries associated with the new schools of pharmacy, among them Adolphe Fabulet (1780–1834) and Edme Jean-Baptiste Bouillon-Lagrange (1764–1844); and, most important, a group of young physicians associated with the Paris Faculty of Medicine and the Paris Society of Medical Chemistry. Members of the latter group wrote a textbook at the beginning of their careers, when they occupied the lowest position in teaching institutions. Important authors include Mateu Orfila (1787–1853), Jean Louis Lassaigne (1800–1859), and Jean Julia de Fontenelle (1790–1842).

The diversification of publics during the third period (1830–1860 or so) coincided with the emergence of a diversity of authors—teachers, medical doctors, apothecaries, plus a new group of professional authors. This last comprised a new generation of young teachers of secondary schools trained at the École Normale in Paris and working in the major French colleges and lycées. They carried out little research and published no texts other than textbooks. Their names (e.g., Deguin, Despretz, Kaeppelin) are unknown to historians of science, even though they wrote books that went through several editions.

Textbooks as Vehicles of Knowledge

Finally, textbooks are a means of transmission of knowledge—transmission that contrary to common opinion was far from being passive. When we started our research, one of our questions was whether textbooks can be original and creative. In fact, it would have been impossible to write a chemistry textbook during the first half of the 19th century without being original or even creative. The authors faced the difficult task of packaging, under the constraints discussed above, a discipline whose limits, organization, and structure were far from established. Chemistry was a science undergoing constant change, with numerous controversies about such fundamental topics as atomic theory or organic types, and with an increasing bulk of new empirical data that were not easy to integrate in earlier frameworks. In this context, textbook authors had no other choice but to make "creative" decisions.

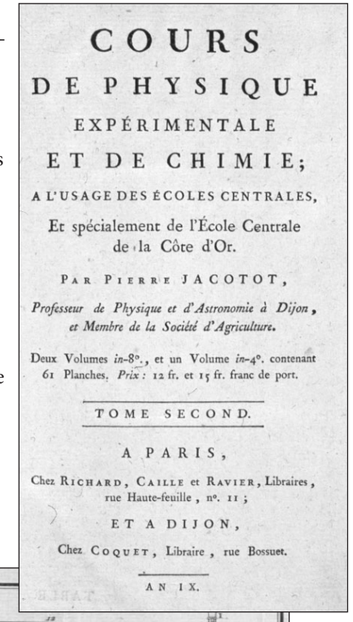
One important feature of chemistry textbooks—classification—illustrates the kinds of decisions that had to be made. During the 19th century, the problem of how to structure a chemistry textbook was closely related to the problem of how to classify chemical substances. At the time chemistry textbooks consisted mostly of descriptions of the properties of chemical substances, and the number of known substances increased dramatically during the first half of the 19th century.

To be sure, other possible textbook structures existed, though none were successful. During the revolutionary years teachers of secondary schools—the new *écoles centrales*—attempted to merge physics and chemistry in a single textbook. In these, descriptive chapters played a minor role in favor of the study of chemical forces, affinities, and imponderable fluids. These textbooks were intended for the students who attended the combined physics and chemistry lectures at the *écoles centrales*.

But after the brief reign of the *écoles centrales* these physics and chemistry textbooks disappeared and were replaced by descriptive chemistry textbooks containing long lists of substances with their properties. These textbooks were aimed primarily at medical students, who needed a long catalogue of chemical substances listing their medical or toxicological uses and describing how to analyze and synthesize them. This need, plus the rapid increase in chemical elements discovered, compelled chemistry textbook writers to face the problem of chemical classification in organizing their texts. They created several chemical classifications, the most famous of which was the "artificial" classification devised by Thénard and widely adopted in France, based (like all "artificial" classifications) on a single property—in this case on the reaction (affinity) with oxygen.

During the 1830s and 1840s chemistry once again gained a place in a new secondary school curriculum, and the number of authors, textbooks, and readers increased. Textbook authors were once again teachers at secondary schools, and they had to deal with a different problem: how to convey a coherent picture of chemistry as a science in a very short time. Including a long list of substances with their properties was useless for that purpose, and as new elements were discovered, organizing them by a single property as Thénard had done became increasingly difficult. Textbook authors thus rediscovered the "natural classifications" introduced into chemistry by André-Marie Ampère two decades before, which grouped substances according to their common properties. Dumas, for example, attempted to create a natural classification by using "atomic volume," heat capacity, and "modes of combination." By memorizing the properties of one substance, sometimes called "the type," from the group, one might guess the properties of the other substances.

After heated debates during the 1830s and 1840s, by the middle of 19th century the structure of textbooks had stabilized, one in which natural and artificial classifications coexisted. One representative example is the popular textbook that Auguste André Thomas Cahours (1813–1891) wrote in the mid-19th century. Cahours employed natural classifications when dealing with nonmetallic elements but classified metallic elements according to Thénard's artificial classification based on



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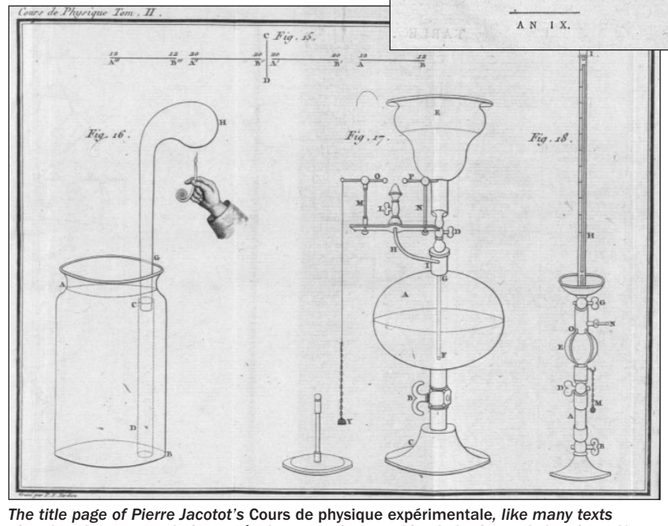
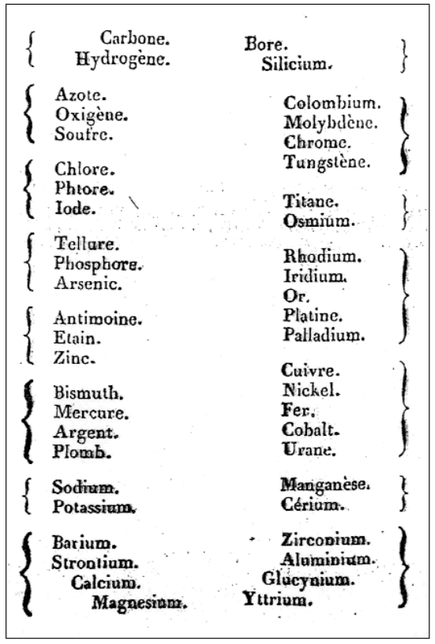
AN IX.



The title page of Pierre Jacotot's Cours de physique expérimentale, *like many texts aimed at the new revolutionary écoles centrales, combined physics and chemistry. Note the revolutionary date "An IX" (1801). Readers of textbooks produced at the turn of the century had to turn to plates at the back, like the one shown here depicting <Eds: what?>, to visualize the apparatus and experiments described in the text. From the Roy G. Neville Chemical Historical Library, CHF.*


Carbone. Hydrogène. — Bore. Silicium.

Azote. Oxigène. Soufre. — Colombium. Molybdène. Chrome. Tungstène.

Chlore. Phtore. Iode. — Titane. Osmium.

Tellure. Phosphore. Arsenic. — Rhodium. Iridium. Or. Platine. Palladium.

Antimoine. Etain. Zinc. — Cuivre. Nickel. Fer. Cobalt. Urane.

Bismuth. Mercure. Argent. Plomb.

Sodium. Potassium. — Manganèse. Cérium.

Barium. Strontium. Calcium. Magnesium. — Zirconium. Aluminium. Glucynium. Yttrium.

This page from an essay by Louis-Marie Ampère in* Annales de chimie *depicts a "table of the 15 genera and 48 species of simple ponderable bodies, arranged in a natural order." From "Essai d'une classification naturelle des corps simples,"* Annales de chimie *2 (1816), 116.

the single criterion of oxygen reactivity.

Textbooks, therefore, are not simply vehicles of "normal," consensual science but a locus for scientific controversy as well. The debate on classification was not imported from a different academic sphere (e.g., research at an academy of sciences), and authors did not simply copy an available classification from other scientific publications and adapt it to their books. The debate over classification took place in forewords and even in special chapters of textbooks, not in journals or academic institutions.

Hybrid classifications such as those employed by Cahours remained central to the structure of French chemistry textbooks, even after Mendeleev's classification was well known in France. No single author was responsible for that outcome: it resulted from the communal enterprise of many authors, most of whom are almost unknown to historians of science. They defended, in some cases, opposite ideas about how to classify chemicals: some argued for natural classifications, others for artificial classifications, and even those who supported artificial classifications disagreed about the groups, families, and so forth.

By the middle of 19th century both natural and artificial classifications coexisted in almost all textbooks, and the hybrid classification was institutionalized in the official syllabus in 1852. Although these two classifications were regarded as incompatible only a few years earlier, textbook authors had to confront powerful institutional and economic requirements—like the 1852 syllabus—to which intrinsic logical and epistemological views inevitably yielded. These works thus exhibit a constrained creativity.

The study of other features, such as chemical atomism, offer a similar conclusion: chemistry textbooks are a valuable scientific literature in which historians of science might find flecks of scientific creativity, a creativity that, as has also been shown for laboratory research, is not made of "eureka" moments nor completely free, but is the result of writing and reading practices. The changing characteristics of textbooks deserve more attention from historians of science—and from all those interested in scientific education.

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Note on symposium

A longer version of this article was written for "Training Scientists, Crafting Science," a conference organized in 2002 by David Kaiser of the Program in Science, Technology, and Society at MIT. The conference was supported by funding from the Spencer Foundation, with additional support from the NSF and from the Provost's Fund at MIT.

For Further Reading

Bernadette Bensaude-Vincent; Anders Lundgren, eds. Communicating Chemistry: *Textbooks and their Audiences, 1789-1939*. Canton, Mass.: History of Science Publications, 1999.

Bernadette Bensaude-Vincent, Antonio García-Belmar, José Ramón Bertomeu Sánchez. *L'émergence d'une science des manuels : Les livres de chimie en France* (1789–1852). Paris: Editions des Archives Contemporaines, 2003.

Bernadette Bensaude-Vincent; José Ramón Bertomeu Sánchez; Antonio García Belmar. "Looking for an Order of Things: Textbooks and Chemical Classifications in 19th-Century France," *Ambix* 49 (2002), 227–250.

David Kaiser, ed. *Pedagogy and the Practice of Science: Producing Physical Scientists, 1800-2000*. Cambridge, Mass.: MIT Press, 2005. In press. <**Aus/Eds: No word of this on MIT Web site**>

José Ramón Bertomeu-Sánchez; Antonio García-Belmar, "Mateu Orfila's Eléments de chimie médicale and the Debate about Chemistry Applied to Medicine during the Early 19th Century in France." *Ambix* 47 (2000) 1–28.