3-1991

The American Career of Jane Marcet's *Conversations on Chemistry*, 1806-1853

Susan M. Lindee
University of Pennsylvania, mlindee@sas.upenn.edu

The American Career of Jane Marcet's *Conversations on Chemistry*, 1806-1853

Abstract
Jane Haldimand Marcet's *Conversations on Chemistry* has traditionally claimed historical attention for its effects on the young bookbinder Michael Faraday, who was converted to a life of science while binding and reading it. Marcet "inspired Faraday with a love of science and blazed for him that road in chemical and physical experimentation which led to such marvelous results," in H.J. Mozans's romantic account. Or, as Eva Armstrong put it, Marcet led Faraday to "dedicate himself to a science in which his name became immortal."[1]

Disciplines
Chemistry | History of Science, Technology, and Medicine | Science and Technology Studies

Jane Haldimand Marcet (1769–1858). Courtesy of the Beckman Center for History of Chemistry.

The American Career of Jane Marcet's *Conversations on Chemistry*, 1806–1853

*By M. Susan Lindee**

JANE HALDIMAND MARCET'S *Conversations on Chemistry* has traditionally claimed historical attention for its effect on the young bookbinder Michael Faraday, who was converted to a life of science while binding and reading it. Marcet "inspired Faraday with a love of science and blazed for him that road in chemical and physical experimentation which led to such marvelous results," in H. J. Mozans's romantic account. Or, as Eva Armstrong put it, Marcet led Faraday to "dedicate himself to a science in which his name became immortal."[1]

In these accounts Marcet is important for her effect on one prominent male scientist. But her influence was much wider: *Conversations on Chemistry* was the most successful elementary chemistry text of the period in America. American publishers printed twenty-three editions of Marcet's text, and twelve editions of an imitative text derived from it. Many young men and women had their first serious exposure to chemistry through the lively discussions of Mrs. B., Emily, and Caroline, the characters Marcet used to convey her ideas. The book was widely used in the new women's seminaries after 1818. There is also evidence that young men attending mechanics' institutes used Marcet's text, and medical apprentices favored it in beginning their study of chemistry.[2]

The widespread use of Marcet's book in the early women's schools is of particular interest. Allusions to domestic applications of science and the spiritual insight it offered were commonly used to justify science instruction for women in these new institutions. But did the texts and style of instruction bear out that justification? If they did not, what might this suggest about the goals and intentions of those offering scientific training to young women?

I have compared Marcet's *Conversations* with other elementary chemistry texts published in the United States between 1806 and 1853. My purpose is to shed some light on the priorities of a poorly understood group: teachers and

* Department of History and Sociology of Science and Beckman Center for the History of Chemistry, University of Pennsylvania, Philadelphia, Pennsylvania, 19104-6310.

Special thanks to Margaret Rossiter, Sally Gregory Kohlstedt, Jeffrey Sturchio, R. Lawrence Moore, and L. Pearce Williams. This essay won the 1988 Schuman Prize.

[1] H. J. Mozans, [John Zahm], *Woman in Science* (New York: Appleton, 1913), pp. 372–373; and Eva V. Armstrong, "Jane Marcet and Her *Conversations on Chemistry*," *Journal of Chemical Education*, 1938, *15*:53–57. L. Pearce Williams gives Marcet's work credit for leading Faraday to connect his fascination with electrical phenomena with forces of "fundamental importance in the universe"—chemical reactions; see Williams, *Michael Faraday: A Biography* (New York: Simon & Schuster, 1965), pp. 18–20.

[2] John K. Crellin, "Mrs. Marcet's *Conversations on Chemistry*," *J. Chem. Educ.*, 1979, *56*:459–460.

administrators at intermediate or college-level women's schools in the first half of the nineteenth century. I show that while these educational reformers had numerous options, they favored a chemistry text that was theoretical and experimental: Marcet's *Conversations on Chemistry*. More "domestic" or practical chemistry textbooks, which were widely available, fared poorly, as did the less common textbooks emphasizing chemistry's spiritual lessons.

School administrators and instructors used domestic and religious justifications to increase the social acceptability of science education for women in the early nineteenth century. My work suggests, however, that the actual instruction at the women's schools promoted feminine interest in scientific theory at a level that exceeded that required for domestic efficiency or religious gratification.

MARCET AND HER SOCIAL CIRCLE

Jane Haldimand Marcet (1769–1858) was born in London of a prosperous Swiss family. When she was thirty years old, she married Alexander Marcet, a London physician and chemist. Her husband's social circle included J. J. Berzelius, Humphry Davy, the botanist Augustin de Candolle, the mathematician H. B. de Saussure, the writers Harriet Martineau and Maria Edgeworth, the political economist Thomas Malthus, the physicist and naturalist Auguste de la Rive, and the chemists Pierre Prevost and Marc Auguste Pictet.[3]

Such social connections gave Marcet access to new ideas and she translated this access into a long, productive writing career. After the success of *Conversations on Chemistry,* her first book, came *Conversations on Political Economy* (1817), *Conversations on Natural Philosophy* (1820), and *Conversations on Vegetable Physiology* (1829). She published anonymously until 1837, and for this and other reasons her works were often attributed either to other women writers, or (in America) to the male commentators whose names appeared on the title page. Marcet's use of "Mrs. B." as the instructor in these conversations led to speculation that the author was Margaret Bryan, a British popularizer of science already prominent when Marcet was a child. Marcet may, of course, have chosen "Mrs. B." as an allusion to Bryan. Marcet's *Conversations* was also attributed to other women writing about science, including Sarah Mary Fitton, who wrote *Conversations on Botany* in 1817.[4]

All of Marcet's later *Conversations* involved the characters—Mrs. B., Caroline, and Emily—introduced in *Conversations on Chemistry*. Caroline, an impetuous and skeptical student, was somewhat more interested in explosions than in fundamentals of science. Emily was serious and bright, and more likely to ask important questions. The two young women were thirteen to fifteen years old (at

[3] Alexander Marcet was a physician and, later, chemistry professor at Guy's Hospital, London. When his wife inherited a substantial fortune upon the death of her father in 1817, Marcet was able to give up medicine and devote himself to chemistry. He was the author of several scientific papers, and his work on the specific heats of gases was cited in other textbooks and in his wife's book. Marcet's social circle is briefly explored in Armstrong, "Jane Marcet" (cit. n. 1). See also Auguste de la Rive's obituary notice for Jane Marcet, "Madame Marcet," *Bibliothèque Revue Suisse et Etrangère,* 1859, N.S., *4*:445–468 (transcription and translation in the Edgar Fahs Smith Collection, University of Pennsylvania, Philadelphia). Alexander Marcet is mentioned in J. R. Partington, *A History of Chemistry* (London: Macmillan, 1972); see also John Read, *Humour and Humanism in Chemistry* (London: Bell, 1947), pp. 177–191, for some biographical details of Marcet's life.

[4] Bryan's works included *A Compendious System of Astronomy* (London, 1797), *A Comprehensive Astronomical and Geographical Class Book* (London, 1815), and *Lectures on Natural Philosophy* (London, 1806).

least, Emily's age was given in *Conversations on Natural Philosophy* as thirteen) and apparently not related. Caroline's father owned a lead mine in Yorkshire, and Emily's family background was not mentioned.[5]

They were young women of wealth, well educated and sensitive to social conventions. In her introduction to the chemistry text Marcet apologized for their intelligence: "It will no doubt be observed that in the course of these Conversations, remarks are often introduced, which appear much too acute for the young pupils, by whom they are supposed to be made. Of this fault the author is fully aware." She explained that the unusual brightness of the pupils was necessary lest the work become "tedious."

In the opening conversation, Caroline claimed to be uninterested in the science of chemistry:

> *Caroline.* To confess the truth, Mrs. B., I am not disposed to form a very favourable idea of chemistry, nor do I expect to derive much entertainment from it. I prefer the sciences which exhibit nature on a grand scale, to those that are confined to the minutiae of petty details.
>
> *Mrs. B.* I rather imagine, my dear Caroline, that your want of taste for chemistry proceeds from the very limited idea you entertain of its object. . . . [Nature's laboratory] is the Universe, and there she is incessantly employed in chemical operations. You are surprised, Caroline; but I assure you that the most wonderful and the most interesting phenomena of nature are almost all of them produced by chemical powers.

When the conversation turned serious, Emily joined in, and the first lesson centered on "constituent" and "integrant" parts. The book then progressed in twenty-six conversations from simple to compound bodies, and from elements to living systems. Marcet included discussions of light and heat, electricity, oxygen and hydrogen, sulfur and carbon, metals, attraction, acidification, decomposition, and animal productions. A twenty-seventh conversation, on the steam engine, was added from 1830 on.

This range of topics indicates the parameters of early nineteenth-century chemistry. The field included—in some fashion—geology, mineralogy, electricity, fermentation, plant respiration, and animal growth. Chemists studied meteors, minerals, animal phosphorescence, medicinal cures, and soil samples. Marcet could, quite reasonably, turn her attention to "bones, teeth, horns, ligaments and cartilage" or to the "effects of Light and air on Vegetation."

But chemistry, however broadly defined, was not the only subject of the text. By the time Marcet wrote her chemistry book, she had already completed her *Conversations on Political Economy* (published later) and some of the themes from that volume made their way into her chemistry lessons. For example, she touched on problems of class. She had Mrs. B. proclaim that the "well-informed" were often too eager to adopt new technology, while the uninformed, "having no other test of the value of a novelty but time and experience" were sometimes able to "prevent the propagation of error." Mrs. B. also praised England's colliers, "digging out of the bowels of the earth one of the most valuable necessaries of life." She expressed disdain for scientific pretense, urging Caroline not to use the word *oxydate* rather than *rust,* "for you might be suspected of affectation."[6]

[5] Jane Marcet, *Conversations on Chemistry* (Hartford, 1839), p. 150 (Caroline's father). For information on the various editions, see Table 1.

[6] 1806 Philadelphia edition, p. 81 (on the well-informed); 1822 Hartford edition, p. 116, and 1839 Hartford edition, p. 125 (on colliers); and 1829 Hartford edition, p. 162 (on *oxydate* vs. *rust*).

Marcet also was aware of the sexual politics of her work and made frequent reference to her feminine readers and their presumed interest in science. In her preface she apologized for daring to publish a work on science, describing her apprehension that her work would be considered "unsuited to the ordinary pursuits of her sex." But the recent establishment of public institutions "open to both sexes, for the dissemination of philosophical knowledge," proved that "general opinion no longer excludes woman from an acquaintance with the elements of science."

She explained that her interest in chemistry was aroused by attendance at the public lectures of Humphry Davy, which she initially found confusing. When the basic concepts of the new chemistry were explained to her in "familiar conversations," Marcet said, she could enjoy Davy's lectures much more. "Hence it was natural to infer that familiar conversation was, in studies of this kind, a most useful auxiliary source of information, and more especially to the female sex, whose education is seldom calculated to prepare their minds for abstract ideas, or scientific language." Her book was written because "there are but few women who have access" to scientific friends, such as her own, willing to converse with them about theory. (John Crellin has suggested that Marcet's "scientific friend" was almost certainly her husband.[7])

At the same time, she did not promote an unseemly female participation in science. When Caroline mentioned pharmaceutical chemistry, Mrs. B. proclaimed that pharmaceutical work "belongs exclusively to professional men, and is therefore the last [branch of chemistry] that I should advise you to pursue."[8]

In its approach to chemistry, Marcet's book was theoretical rather than practical. She updated her treatment of important ideas in later editions, and at least on some topics her elementary text kept pace with scientific changes. She followed Antoine-Laurent Lavoisier's scheme of classification of the elements, as laid out in the 1796 English translation of his *Traité élémentaire de chimie,* considering light, electricity, and caloric "imponderable agents." She somewhat conservatively clung to the caloric theory, however, even after Davy had abandoned it. She used a Newtonian, corpuscular theory of matter, and she explained chemical reactions in terms of affinity, aggregation, gravitation, and repulsion.[9]

Marcet did not mention John Dalton's atomic theory until after 1819, and even then she expressed doubts about its validity. This in part reflected Davy's skepticism. But it was a skepticism widely shared; many other writers of chemistry texts, including Thomas Thomson, W. T. Brande and Andrew Ure, continued to question Dalton's theory (as an explanation for the fundamental nature of matter) until as late as 1841.[10]

[7] Crellin cites a December 1803 letter from the London physician John Yelloly to Alexander Marcet, in which Yelloly seems to imply that Alexander is responsible for the quality of Jane's (as yet unpublished) manuscript: Crellin, "Marcet's *Conversations on Chemistry*" (cit. n. 2).

[8] 1839 Hartford edition, p. 14.

[9] A.-L. Lavoisier, *Principles of Chemistry in a New Systematic Order,* trans. from the 2nd French ed. (1793) by Robert Kerr (Edinburgh, 1796). David Knight's comparison of Marcet's chemistry and that of Samuel Parkes, a contemporaneous writer who wrote for young men, emphasizes Marcet's theoretical assumptions; see Knight, "Accomplishment of Dogma" (cit. n. 4).

[10] Thomas Thomson, *A System of Chemistry of Inorganic Bodies* (Edinburgh, 1831), pp. 3–31; W. T. Brande, *A Manual of Chemistry* (London, 1841), pp. 234–238; and Andrew Ure, *A Dictionary of Chemistry* (London, 1831), pp. 443–445. I am indebted to J. R. Clarke for these useful comparisons, explored in his unpublished paper "Jane Marcet and Her *Conversations on Chemistry*" (J. R. Clarke, 15 Exeter Grove, Belmont, Victoria 3216, Australia).

Despite its elementary nature, Marcet's treatment of chemical theory compared favorably with that of the Scottish chemist Edward Turner in his much-admired college-level textbook *Elements of Chemistry*. Turner's book, first published in 1827, was about as widely used and imitated as Marcet's. He had at least three near-plagiarists in America: Lewis C. Beck, John Lee Comstock (one of Marcet's editors), and John Johnston all produced chemistry texts that depended heavily on Turner. They borrowed his organizational format, illustrations, charts, appendixes and, in many cases, his words. All acknowledged their debt to Turner, stating that their work was "on the basis of Turner's *Elements of Chemistry*" or that Turner was "used more freely than any other" author.[11] Both Turner's text and those drawn from it were popular in American men's colleges.

Marcet's handling of chemical theory was remarkably consistent with Turner's. In a point-by-point comparison of the two authors' treatment of heat as an "imponderable substance," the correlation of the subjects explored and scientists cited is very high. Both discussed William Herschel's studies of light and heat, John Leslie's work with the radiation of heat, Marc-Auguste Pictet's *Essai sur le feu,* Count Rumford on clothing and the conduction of heat, William Wells's theory of the formation of dew, the problem of cold as the absence of heat (rather than as a negative quality), the use of a pyrometer, and Pierre Prevost's studies of radiation.[12]

Marcet's text also kept pace with William Brande's *Manual of Chemistry*. Brande was professor of chemistry at the Royal Institution (appointed to replace Humphry Davy in 1812), and his text was intended as an advanced accompaniment to his three-month lecture course for men, which he taught with Faraday as his assistant. Brande's and Marcet's classification schemes were very similar, with Marcet's in some ways superior. She organized the elements on the basis of their presumed nature, and she attempted to construct a meaningful system that would help her students understand the processes of chemistry. Marcet's book would have covered Brande's course adequately, for the topics listed in his syllabus and those discussed by Marcet were largely the same.[13]

These comparisons suggest that Marcet's book was no collection of tips for homemakers and farmers, but an introduction to the most important chemical theories of her day. Its popularity in the new women's schools in America therefore raises questions about the goals and priorities of the educational reformers who taught there.

MARCET'S *CONVERSATIONS* IN AMERICA

Conversations on Chemistry was first published in London in 1806. The first American edition appeared later that same year. From 1806 to 1850, American publishers made twenty-three impressions of various editions of the work, at Hartford, Boston, Philadelphia, New Haven, and New York.[14] There were also

[11] See Lewis C. Beck, *A Manual of Chemistry* (Albany, N.Y.: Webster & Skinners, 1831); John Lee Comstock, *Elements of Chemistry* (New York: Robinson, Pratt, 1839); and John Johnston, *A Manual of Chemistry* (Philadelphia: Charles Desilver, 1861) (1st pub. 1848).

[12] Cf. Marcet, 1839 Hartford edition, conversations 2 and 3, with Edward Turner, *Elements of Chemistry* (1842), pp. 9–50.

[13] Clarke makes this comparison in "Marcet and Her *Conversations on Chemistry*" (cit. n. 10).

[14] The book was often printed more than once in a single year by competing publishers, e.g., by Increase Cooke of New Haven and James Humphreys of Philadelphia in 1809. Two or more runs of Marcet's book or the imitative Thomas P. Jones *New Conversations on Chemistry* were also produced by various American publishers in 1818, 1824, 1831, 1836, 1839, and 1844. Cornell's efficient

Table 1. Printings of American Editions of Marcet's *Conversations on Chemistry.*

1806	Jane Marcet. *Conversations on Chymistry*. Philadelphia: James Humphreys on Change Walk. "In which the elements of that science are familiarly explained and illustrated by experiments and plates."
1809	Jane Marcet. *Conversations on Chemistry*. New Haven: Increase Cooke & Co. "To which are added some late discoveries on the subject of the fixed alkalies, by H. Davy; A description and plate of the pneumatic cistern at Yale College—and a short account of artificial mineral waters in the United States."
	Jane Marcet. *Conversations on Chemistry*. Philadelphia: James Humphreys. With "an appendix consisting of a description of the new hydro-pneumatic blow pipe . . . also of three disquisitions, one on dyeing, one on tanning and one on currying."
1813	Jane Marcet. *Conversations on Chemistry*. New Haven: Increase Cooke & Co.
1814	Jane Marcet. *Conversations on Chemistry*. New Haven: Sidney's Press.
1818	Jane Marcet. *Conversations on Chemistry*. Greenfield, Mass.: Denio & Phelps. "From the 4th and latest English edition, revised, corrected, and considerably enlarged. To which are added notes and observations: by an American gentleman" (Comstock).
	Jane Marcet. *Conversations on Chemistry*. Philadelphia: M. Carey & Son. "Rev. and cor. by Thomas Cooper, M.D., from the 5th London, considerably enl."
1820	Jane Marcet. *Conversations on Chemistry*. Greenfield, Mass.: Denio & Phelps. Additions by "an American gentleman" (Comstock).
1822	Jane Marcet. *Conversations on Chemistry*. Hartford: O. D. Cooke & Co. "To which are now added explanations by J. L. Comstock."
1824	Jane Marcet. *Conversations on Chemistry*. Hartford: Cooke. Additions by Comstock.
	Jane Marcet. *Conversations on Chemistry*. Philadelphia: Thomas DeSilver; Baltimore: J. E. Coale. 10th American ed. "Anonymous." Comments by William H. Keating.
1826	Jane Marcet. *Conversations on Chemistry*. Hartford: Cooke. "To which are now added, explanations of the text by J. L. Comstock, M.D., together with a new and extensive series of questions by Rev. J. L. Blake."
1828	Jane Marcet. *Conversations on Chemistry*. Hartford: Cooke. "To which are now added explanations of the text, directions for simplifying the apparatus, and a vocabulary of terms—together with a list of interesting experiments" by Comstock, with questions by Blake.
1829	Jane Marcet. *Conversations on Chemistry*. Hartford: Cooke. 11th American ed. from the 8th London ed. Additions by Comstock and Blake.
1830	Jane Marcet. *Conversations on Chemistry*. Hartford: Cooke. 12th American ed. Additions by Comstock and Blake.
1831	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: John Grigg. "Adapted to the present state of that science; wherein its elements are clearly and familiarly explained. With one hundred and eighteen engravings . . . appropriate questions; a list of experiments, and a glossary. On the foundations of Mrs. Marcet's Conversations on Chemistry."
	Jane Marcet. *Conversations on Chemistry*. Hartford: Cooke. 13th American ed. from the last London ed. Additions by Comstock and Blake.
1832	Thomas P. Jones, *New Conversations on Chemistry*. Philadelphia: Grigg.

NOTE: Numbers for the various editions are those given by the respective publishers.

Table 1—*continued*

1833	Jane Marcet. *Conversations on Chemistry*. Hartford: Cooke. 14th American ed. Additions by Comstock and Blake.
	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Grigg.
1834	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Grigg.
1835	Jane Marcet. *Conversations on Chemistry*. Hartford: Beach & Beckwith. 15th American ed. Additions by Comstock and Blake.
1836	Jane Marcet. *Conversations on Chemistry*. Hartford: John Beach; New York: Collins, Keese & Co. 15th American ed. Additions by Comstock and Blake.
	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Grigg.
1838	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Grigg.
1839	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Grigg.
	Jane Marcet. *Conversations on Chemistry*. Hartford: Belknap & Hamersley. 15th American ed. Additions by Comstock and Blake.
1841	Jane Marcet. *Conversations on Chemistry*. Hartford: Belknap & Hamersley. 15th American ed. Additions by Comstock and Blake.
1842	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Grigg & Elliot.
1844	Jane Marcet. *Conversations on Chemistry*. Hartford: Belknap & Hamersley. 15th American ed.
1845	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Grigg & Elliot.
1846	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Grigg & Elliot.
1848	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Grigg & Elliot.
1850	Jane Marcet. *Conversations on Chemistry*. Hartford: Belknap & Hamersley. Additions by Comstock and Blake.
	Thomas P. Jones. *New Conversations on Chemistry*. Philadelphia: Lippincott, Grambo.

twelve printings of a highly imitative American text, *New Conversations on Chemistry,* by Thomas P. Jones. Marcet's book was almost as popular in Britain, going through eighteen printings.[15] It was printed four times in Paris (perhaps more, since Marcet had at least one French plagiarist) and once in Geneva.[16] The book was a failure in Germany, where a single 1839 edition sold poorly.[17]

Olin Library staff assisted me in tracking down sixteen of these twenty-three American editions, held in various libraries in the United States, and four editions of the version by Thomas P. Jones. Thanks also to the libraries that made copies available: University of Pennsylvania, University of Michigan, Princeton University, New York State Library at Albany, and University of Minnesota.

[15] The book's popularity in Britain has been dismissed by some historians as a by-product of Humphry Davy's charisma; see Judit Brody, "The Pen Is Mightier Than the Test Tube," *New Scientist,* 14 Feb. 1985, p. 58. See also David Knight, "Accomplishment of Dogma: Chemistry in the Introductory Works of Jane Marcet and Samuel Parkes," *Ambix,* 1988, *33*:94–98, on p. 97.

[16] Jean Jacques has noted the anonymous publication in Paris in 1826 of *Entretiens sur la chimie après les méthodes of MM. Thenard et Davy,* virtually a direct translation of Marcet's text. Mrs. B. became Mme de Beaumont, Emily was transformed to Gustave, but Caroline remained Caroline. The same year A. Payen produced a version under the title *La chimie enseignée en vingt-six leçons).* Though he restyled portions of the text, he lifted the order of the conversations and many discussions directly from Marcet's text. Jean Jacques, "Une chimiste qui avait de la conversation: Jane Marcet (1796–1858)," *Nouveau Journal de Chimie,* 1986, *10*:209–211.

[17] A modern facsimile of the German edition was published in 1984, with an afterword by the historian of chemistry Otto Paul Krätz (*Unterhaltungen über die Chemie,* trans. F. F. Runge [Wein-

A contemporary commentator set American sales figures at 160,000 copies.[18]

Marcet did not intend her *Conversations* to be used as a textbook. In Britain, it was apparently used as she expected, as a guide to popular lectures on chemistry or natural philosophy. But in America it became the most successful elementary chemistry text of the first half of the nineteenth century. A succession of male editors reshaped it for classroom use through twenty-three pirated American editions over forty-seven years. Indeed, as noted earlier, the work was commonly attributed (in biographical dictionaries, catalogues and obituaries in the United States) to its male editors.[19] In the absence of international copyright law, Marcet received no income from these American editions, nor had she any control over the American commentaries and improvements.[20]

The American editors added study questions, dictionaries of terms, guides to the experiments, and critical commentaries. These amendments for the classroom were not a marketing strategy concocted by the book's American publishers, but the response of professional chemists and educators to the book's growing use as an introductory chemistry text. *Conversations on Chemistry* was widely adopted in the schools by 1818. It then attracted American editors, most of whom seemed to be disturbed by its popularity.

Marcet's American commentators included a minister and four professors of chemistry or chemical lecturers. They worried about questionable theories (Davy's) and dangerous experiments. They also attempted to promote American scientists—Robert Hare, whom Marcet neglected, and Benjamin Franklin, whom she misinterpreted.[21]

---

heim: Verlag Chemie, 1984]). Krätz concluded that the book failed in Germany because it discussed technologies, such as steam engines, unfamiliar to German readers. Karl Hufbauer has suggested that it may not have been successful because young German women had limited access to chemical education: see Hufbauer's review, *CHOC News*, Spring 1984, 2(1):7–8, on p. 8.

[18] It is difficult to determine exactly how many copies of Marcet's work sold in America. Sarah J. Hale provided the figure of 160,000, cited by several other historians, in Sarah Josepha Buell Hale, *Woman's Record; or, Sketches of Distinguished Women from the Creation to A.D. 1868, Arranged in Four Eras* (New York, 1874), p. 732. But Hale refers to 160 impressions of the book and assumes a print run of 1,000 copies per impression. I have managed to find records of only 32 impressions (counting Jones's version). Hale may have known of more, or perhaps print runs were much larger.

[19] Thomas P. Jones included Marcet's name in the frontispiece of all his editions, but the text was listed as his work in catalogues of texts used in chemical instruction in the women's academies. See Thomas Woody, *A History of Women's Education in the United States* (Lancaster, Pa.: Science Press, 1929), p. 553. Woody also lists John Lauris Blake, the Episcopalian minister who provided questions for numerous editions, as the author of a chemistry text that must have been Marcet's work: Blake's questions appeared in every American edition after 1828. (Woody again lists Blake as the author of a natural philosophy text that must have been Marcet's later *Conversations on Natural Philosophy*, to which he added similar questions.) Blake also appears as the author of *Conversations on Chemistry* in the *Dictionary of American Biography* (1936), Vol. XI, p. 343, and the *National Cyclopedia of American Biography* (1931), Vol. XXI, p. 172. This attribution of male authorship must have been the work of persons who had not read the book, since every edition carried Marcet's self-deprecating preface, which was clearly written by a woman, and was almost unchanged for forty-four years.

[20] Protection of copyright for American authors was established in 1790, but foreign authors were granted no such protection until 1891. The publication of Marcet's book in America was also influenced by the chaotic and competitive nature of early nineteenth-century book publishing. The "cutthroat" conditions of the era "forced many publishers to specialize in fields where competition was not so general and returns more stable," such as science: Henry Walcott Boynton, *Annals of American Bookselling, 1638 to 1850* (New York: John Wiley, 1932), p. 144. See also Warren S. Tryon and William Charvat, eds., *The Cost Books of Ticknor and Fields* (New York: Bibliographical Society of America, 1949)—a reprint of the publishing records of a major Boston publisher from 1832 to 1858.

[21] For a discussion of American envy of European chemistry see Robert V. Bruce, *The Launching of Modern American Science, 1846–1876* (New York: Knopf, 1987), pp. 14–28.

Marcet's most frequent editor was John Lee Comstock, who made his debut anonymously in the fourth edition of 1818 as "an American gentleman." His name first appeared in the 1822 Hartford edition. In 1826 O. D. Cooke produced an edition of *Conversations on Chemistry* with both Comstock's commentary and a series of numbered "study questions" provided by the Rev. John Lauris Blake. The combination of Comstock's criticisms and Blake's questions was the standard format for most American editions throughout the rest of the book's career.

Blake (1788–1857) was an Episcopalian minister in Boston. He had resigned his rectorship in 1822 to devote himself to "literary work," which included writing an introductory astronomy book and providing numbered study questions to both Marcet's *Conversations on Chemistry* and her later *Conversations on Natural Philosophy*. Blake must have been interested in the education of women: he started a girl's school at Concord, New Hampshire.[22] His questions in Marcet's chemistry book (1,456 of them in the 1836 Hartford edition) were printed at the bottom of each page and intended to aid in classroom instruction. On the title page Blake warned (in triple negative) that "no small portion of learners will pass over without study, all in which they are not to be questioned."

Blake's questions were not particularly thought provoking—they promoted rote learning—but they were apparently taken seriously by some students. In several copies of Marcet's text reviewed for this study, some long-ago student had dutifully penciled in the proper answers to these questions in the small space allotted on the page.

Comstock (1789–1858) was a self-educated surgeon who served in the Army in the War of 1812 and later settled in Hartford to write and edit textbooks on chemistry, natural history, botany, physiology, and mineralogy. Comstock's "original" work was apparently often borrowed from European authors. The *Dictionary of American Biography* credits him with the authorship of a *History of Gold and Silver,* a *History of the Greek Revolution* and a *Cabinet of Curiousities*.[23] He also wrote a highly derivative chemistry text: his *Elements of Chemistry* (1831) was a much-simplified and quite popular version of Turner's text of the same name. His 1822 *Grammar of Chemistry* was apparently also borrowed from another author. It was written "on the plan of David Blair," a pseudonym of R. Phillips, and "adapted to the use of schools and private students by familiar illustrations and easy experiments."[24] And Comstock's *Conversations on Natural Philosophy* was in fact Marcet's work, with his name on the title page as editor.

Two other American editors, the Philadelphia chemistry professors William H. Keating and Thomas Cooper (who produced one edition each), merely inserted a few mild footnotes clarifying Marcet's experiments or ideas.[25] But Comstock, her first and most persistent American editor, provided from 156 to 173 notes in

[22] *National Cyclopedia of American Biography* (1931), Vol. XXI, p. 172.

[23] On Comstock see *Dictionary of American Biography* (1872), p. 211; see also the extensive list of Comstock's publications in John F. Ohles, *Biographical Dictionary of American Educators* (Westport, Conn.: Greenwood, 1978), Vol. I, p. 295.

[24] John Lee Comstock, *A Grammar of Chemistry* (Hartford: S. G. Goodrich, 1822), title page.

[25] Keating was founder of the Franklin Institute and a chemistry professor at the University of Pennsylvania. Cooper was the son-in-law of Joseph Priestley, a professor of chemistry and mineralogy at the University of Pennsylvania, and, after 1821, a chaired professor of chemistry at South Carolina College.

his various editions, for a text averaging about 330 pages. In these notes he frequently disagreed with Marcet and sometimes implied that she was incompetent. When she explained the presence of so much "calcareous matter" as the "effect of a general combustion occasioned by some revolution of our globe," Comstock noted: "This idea is at random. We cannot account for the origin of carbonic acid in its native state, any better than we can for oxygen."[26] When Marcet suggested that it was highly unusual for three or more substances to combine without any of them being precipitated, Comstock noted that "such compounds are quite numerous." He characterized her explanation of volcanoes as "supposition piled on supposition."[27] When she attempted to explain the role of water in the life cycle of plants, he responded in a footnote: "The foregoing paragraph might mislead the student. Indeed, it seems to have been written without regard to proper authorities." When she suggested that "combustion is the result of intense chemical action," he responded: " 'Intense chemical action' neither explains the process, nor, indeed conveys to the mind any definite idea."[28] And when she said the concepts of negative and positive indicated "different quantities of the same kind of electricity," Comstock replied (with italics): "In this chapter, Mrs. B. has used these terms of the American philosopher [Franklin] improperly, for *plus* and *minus* were never meant to signify two sorts of electricity, but only its *presence* or *absence*."[29]

If Comstock disapproved of many of Marcet's proposals (both theoretical and experimental) why did he continue to edit the book vigorously for four decades? His introduction provides a partial explanation: Comstock was worried about the book's widespread use in the classroom. "Known and allowed facts are always of much higher consequence than theoretical opinions," he said in the "Advertisement of the American Editor" that introduced his editions. "A book designed for the instruction of youth, ought, if possible, to contain none but established principles."[30]

Keating and Cooper, while milder in their criticisms of Marcet, also expressed concern about the promotion of questionable theories to beginning students. Cooper edited the text "lest the young student should adopt as certainties many theoretical views which have hardly yet arrived at probability." He noted that Marcet had followed Davy where his contemporaries "have not yet dared to follow him." This adoption of Davy's ideas rendered the book "extremely interesting" but less than ideal for instruction in the fundamentals of chemistry.[31]

Marcet's editors also worried about her depiction of the use of hands-on laboratory experiment in the training of beginners. They found such a proposal extremely risky, and their concerns were not unwarranted. From Comstock's corrections of her experiments, it appears possible that Marcet did not actually perform all the experiments she described. Certainly her suggestion that elementary chemical instruction might include laboratory experiment was quite novel. Indeed, in 1822 her editor William Keating, of the University of Pennsylvania

[26] 1829 Hartford edition, p. 225.
[27] 1825 Hartford edition, pp. 13, 172.
[28] 1839 Hartford edition, pp. 281 (water), 234 (combustion).
[29] 1822 Hartford edition, p. 79.
[30] This introduction, essentially unchanged, is printed in every impression of Comstock's version, before the table of contents.
[31] Thomas Cooper, 1818 Philadelphia edition, preface; see also William H. Keating, 1824 Philadelphia edition.

and the Franklin Institute, was one of the first to apply this teaching method in an American college. It was not until after the Civil War that laboratory instruction for beginning students became the norm.[32]

While her other American editors merely inserted footnotes or study questions, Thomas P. Jones wrote a "new" text that followed Marcet's format precisely in terms of data presented, but eliminated the humor and personal commentary of the original. Jones, a professor of chemistry at Columbia College in Washington and a popular lecturer on chemistry and natural philosophy, was interested in filling the text with as many chemical facts as possible.[33] Publishing his first version of Marcet's book in 1831, he explained that while Marcet's text received "deservedly high praise" and had "contributed more than any other work to promote the study of chemistry," its original role as "companion for the parlour" had been superseded. The new role of textbook called for a different presentation. The digressions which gave the original work "variety and interest" in the "family circle" were now an impediment to the rapid assimilation of new facts, he said.[34] Jones's version, though lacking the entertainment value and "charm" which might be assumed to be one reason for Marcet's success, was relatively successful itself: it was reprinted twelve times, more frequently than most other chemistry texts of the era.

Marcet's American editors suggested that she went too far in her promotion of the latest chemical theories. Yet her discussions of theory may have been what academy-level instructors found so attractive. And the proposed experiments her editors found so risky may have made her work more valuable to instructors hoping to spark young women's interest in science.

SCIENCE IN THE WOMEN'S ACADEMIES

The antebellum women's academies have been a subject of increasing historical interest since 1979. Science instruction at these institutions was touched on in Thomas Woody's classic 1929 history of education for women. In 1979 Deborah Jean Warner examined more precisely the kinds of instructions and instructional materials that women's academies offered. Linda Kerber and Anne Firor Scott have explored their complex cultural role, suggesting that practice was not always in line with public rhetoric. Those promoting women's education for the sake of "republican motherhood" (the rearing of good male citizens who could defend the republic) may have had more radical intentions. And as Patricia Cline Cohen has shown, women's education in mathematics was predicated on the household applications of numerical reasoning (as in knitting or cooking), while actual instruction was much more advanced than these simple tasks required.[35]

[32] See Wyndham Miles, "William H. Keating and the Beginning of Chemical Laboratory Instruction in America," *Library Chronicle,* 1952/3, *29*:1–34. See also the entry on Keating in *Dictionary of American Biography* (1872), p. 502.

[33] Wyndham D. Miles, "Public Lectures on Chemistry in the United States," *Ambix,* 1968, *15*:129–153.

[34] Thomas P. Jones, *New Conversations on Chemistry* (Philadelphia: John Grigg, 1832), preface.

[35] Woody, *History of Women's Education* (cit. n. 19), Vol. I; Deborah Jean Warner, "Science Education for Women in Ante-Bellum America," *Isis,* 1979, *69*:58–67; Linda K. Kerber, *Women of the Republic: Intellect and Ideology in Revolutionary America* (Chapel Hill: Univ. North Carolina Press, 1980); Anne Firor Scott, "The Ever-Widening Circle: The Diffusion of Feminist Values from the Troy Female Seminary, 1822–1872," *History of Education Quarterly,* Spring 1979, pp. 3–25; and Patricia Cline Cohen, *A Calculating People: The Spread of Numeracy in Early America* (Chicago: Univ. Chicago Press, 1982), pp. 134–149.

Certainly the historical picture of both the women's academies and the role of science therein is incomplete. Some sciences, including chemistry, were more widely taught in the women's academies than in boys' high schools of the early nineteenth century. And at least some women's schools, particularly Emma Willard's Troy Female Seminary, offered a greater range of sciences than contemporary men's colleges.[36]

Laboratories and observatories at the female colleges were not well funded, but they represented the single largest investment, excepting buildings, at many schools. A women's school in New York City, Abbott Collegiate Institute, claimed scientific apparatus "unsurpassed in character by that of any other Institution in our country." Astronomical equipment was particularly popular. Albany Female Academy and Packer Collegiate Institute each owned an orrery, a moving, mechanical representation of the solar system, made by a renowned Kentucky instrument maker.[37]

Such equipment, as Deborah Jean Warner has noted, proves nothing about the quality of science teaching. The paraphernalia was as important for promotional as for educational reasons. Yet she argues that other evidence suggests that the quality of the instruction in some sciences was relatively high. Some lecturers appearing at the women's schools were well known (Benjamin Silliman, Jr.; Elias Loomis), and some science teachers were extremely competent, among them Alonzo Gray, who taught at Brooklyn Female Academy, and Louis Agassiz, who with his wife Elizabeth ran a school for girls in Cambridge from 1855 to 1863.[38]

The availability of scientific apparatus and the high quality of some instructors suggest that science education at the women's academies was more than a public relations ploy. The selection of textbooks reinforces this conclusion. Those teaching chemistry to young women in this period had numerous options. Their choice of Marcet's text indicates their educational priorities. It suggests that their commitment to scientific instruction for women was not completely encompassed in their publicly stated goals. Textbooks conforming more properly to these stated goals were widely available before 1840. Most emphasized the practical applications of chemistry. But at least one important American chemistry text focused on the spiritual lessons it provided. This was the text of the American educator Almira Hart Lincoln Phelps, the sister of Emma Willard.[39]

Phelps should have had considerable insight into the instructional materials needed in the new women's schools. Yet her academy-level chemistry text, spe-

[36] See the discussion in Paul J. Fay, "The History of Chemistry Teaching in American High Schools," *J. Chem. Educ.*, 1931, *8*:1533–1562, 1539–1540. For a valuable review of the state of chemical instruction in American colleges see Bruce V. Lewenstein, " 'To Improve Our Knowledge in Nature and Arts': A History of Chemical Education in the United States," *J. Chem. Educ.*, 1989, *66*:37–44.

[37] Warner, "Science Education for Women" (cit. n. 32), pp. 59, 60 (quotation from Abbott Collegiate Institute, *Catalogue* [1854]).

[38] Warner, "Science Education for Women," p. 62.

[39] Almira Hart Lincoln Phelps, *Familiar Lectures on Chemistry* (New York: F. J. Huntington, 1838). Besides works cited in notes 11, 43, and 44, I have considered the following texts: William Henry, *An Epitome of Chemistry* (Boston, 1810); John White Webster, *Manual of Chemistry* (Boston, 1826); Edward Turner, *Elements of Chemistry* (New York, 1828); James Renwick, *First Principles of Chemistry* (New York, 1840); Benjamin Silliman, *First Principles of Chemistry* (Philadelphia/Boston, 1847); Edward Youmans, *A Class Book of Chemistry* (New York, 1851); and Youmans, *The Handbook of Household Science* (New York, 1853). For textbooks used in women's academies for other sciences see Woody, *History of Women's Education* (cit. n. 19), Vol. I, app.

cifically intended for the instruction of young women, was a failure: it was reviewed unenthusiastically and printed only twice, in 1838 and 1842.[40] Phelps's error may have been her assumption that chemical education was a form of religious instruction. While Marcet mentioned the relevance of chemical theory to religious faith only casually, Phelps's *Familiar Lectures on Chemistry* was metaphysical throughout. She said chemistry could provide lessons in humility—"Our own bodies are composed of a few elements of the same nature as those which form the very worm that crawls"—and in hubris: "There is a portion of ourselves which is beyond the scope of chemical science, which cannot be analyzed, because it is incapable of being separated into parts."[41]

While Phelps's primary interest was in the spiritual lessons of science, she also recognized that chemistry had a peculiarly practical aspect. She assigned her pupils to explain the "Chemical Principles involved in making bread" and informed them that chemistry had "an important relation to housekeeping . . . in the making of gravies, soups, jellies and preserves, bread, butter and cheese, in the washing of clothes, making soap, and the economy of heat in cooking, and in warming rooms."[42]

Other writers considered the utilitarian aspect of chemistry its chief value to potential students. The useful purposes these writers selected for discussion shifted with the intended audience. An author intending to address the problems of "household science" might discuss the relevance of chemical facts to the fermentation of bread, preservation of milk and butter, sources of impure air in the home, and properties of fuel used for artificial heating. Another, intending to reach workingmen, would focus on tanning leather, brewing wine, soil analysis, and medicine. John R. Coxe's translation of M. J. B. Orfila's *Practical Chemistry* (1818) contained little chemical theory, focusing instead on information useful to the pharmacist, farmer, or physician. Similarly, William Henry's *Elements of Experimental Chemistry* classified metals practically, rather than theoretically, and dealt solely with the relation of chemistry to the "practical arts." The American physician and Harvard chemistry professor John Gorham deemed even Henry's chemical text too experimental, and in his *Elements of Chemical Science* (the first original American chemistry textbook) simplified Henry's approach by eliminating virtually all laboratory work. John Lee Comstock's own text, *Elements of Chemistry,* first published in 1831, was an entirely descriptive and practical text that gave no attention to chemical theory. Even as late as 1867 J. Dorman Steele's popular *Fourteen Weeks in Chemistry* concerned only that "practical part of chemical knowledge" necessary in the "schoolroom, the kitchen, the farm and the shop." And a masculine version of Marcet's *Conversa-*

[40] Phelps's 1834 text for children, *Chemistry for Beginners,* was slightly more successful, and editions continued through the 1860s. Her most popular book was *Familiar Lectures on Botany,* which was reprinted dozens of times and had sold 230,000 copies by 1870. Phelps's biographer Emma Lydia Bolzau has attributed the failure of the chemistry texts to their derivative nature; see Bolzau, *Almira Hart Lincoln Phelps* (Lancaster, Pa.: Science Press, 1936), pp. 235–236.

[41] Phelps, *Chemistry for Beginners* (1867), p. 11. Marcet's most sustained discussion of chemistry and religious faith appeared in the closing paragraph of her book: "To God alone man owes the admirable faculties which enable him to improve and modify the productions of nature. . . . In contemplating the works of the creation, or studying the inventions of art, let us, therefore, never forget the Divine source from which they proceed; and thus every acquisition of knowledge will prove a lesson of piety and virtue." 1822 edition (e.g.), p. 327.

[42] Phelps, *Chemistry for Beginners* (1839), p. 5 (bread making); (1867), pp. 9–11 (housekeeping).

tions on Chemistry, the Rev. Jeremiah Joyce's *Dialogues in Chemistry,* featured conversations between a "Tutor" and two male pupils, Charles and James, on the relevance of chemistry to "agriculture, gardening and the arts of cooking and of making wine, beer and other fermented liquors."[43]

An introductory text that combined all these interests rather broadly was produced in 1822 by the New York educator Amos Eaton, a friend of both Almira Hart Lincoln Phelps and her sister Emma Willard. Eaton dedicated his *Chemical Instructor* to Willard because she was "the first in the interior of the Northern states to introduce experimental chemistry into [public] schools."[44] Eaton's text, written to replace Marcet's, which he disliked, was intended for the audience—academy chemistry instructors—that had already demonstrated its enthusiasm for her approach. Eaton interpreted that market as receptive to a practical treatment of the subject. He was unwilling to let a single chemical idea or principle pass without mentioning a practical application: he made special appeals to those engaged in the full-time management of a house. His intentions were egalitarian and democratic. He proposed simple, inexpensive experiments, recognizing that his readers might not have access to expensive chemical equipment or rare materials; part of his objection to Marcet was that she assumed her readers would have ample access to equipment and supplies.[45]

But Eaton's book was not widely used in the women's academies. Instead, many instructors of young women continued to introduce chemistry through Marcet's *Conversations on Chemistry,* a work that overlooked the domestic or practical applications Eaton and other American writers believed to be so important.[46]

CONCLUSION

By the 1820s "popular science" tailored to a female audience was a well-accepted social activity. From these public lectures and popular books women supposedly gained lessons in piety and useful household tips. School administrators at the women's academies transferred this reasoning to the formal educational setting. They offered their students those sciences promoted for women in popular lectures and books: natural philosophy, astronomy, chemistry, and botany.

But popular lectures and popular science books were casual entertainment,

[43] M. J. B. Orfila, *Practical Chemistry,* trans. from the French by John Coxe (Philadelphia: Thomas Dobson, 1818); William Henry, *The Elements of Experimental Chemistry* (Philadelphia: R. Desilver, 1822–1823); John Gorham, *The Elements of Chemical Science* (Boston: Cummings & Hilliard, 1819); Comstock, *Elements of Chemistry* (cit. n. 11); J. Dorman Steele, *Fourteen Weeks in Chemistry* (New York: Barnes, 1867); and Jeremiah Joyce, *Dialogues in Chemistry* (New York: James Eastburn, 1818). The quotation is from the third London edition, with "additional notes by an American professor of chemistry." In her third London edition Marcet stated that her format (a teacher and two students) was borrowed from a book entitled *Scientific Dialogues.* This was probably an earlier book by Joyce, who also wrote *Dialogues on the Microscope.* See Marcet's preface, 1809 (e.g.).

[44] Amos Eaton, *Chemical Instructor* (Albany: Websters & Skinners, 1822), dedication. The work went into four editions in Albany (1822, 1826, 1828, 1833). On the relationship between Eaton, Phelps, and Willard see Lois Barber Arnold, *Four Lives in Science: Women's Education in the Nineteenth Century* (New York: Schocken, 1984).

[45] Eaton, *Chemical Instructor* (1822), title page.

[46] As early as 1809 Marcet's New Haven publishers added a "description and plate of the pneumatic cistern of Yale College," a "short account of artificial mineral waters," and an appendix "consisting of treatises on dyeing, tanning and currying"; see 1809 New Haven edition.

essentially conservative, legitimated by the presumed domestic and religious applications of scientific knowledge. Education at the female academies entailed institutional approval of a sustained course of study of science, however elementary; there was often an implicit expectation that some students would pursue careers as teachers. While both activities were justified in similar ways, they reflected fundamentally different assumptions about female involvement in science. The conservative arguments that made sense of science education for women apparently had little impact on actual scientific instruction, which (at least in the case of chemistry) was often focused less on spiritual or domestic applications than on chemical theory and experiment.

Despite competition from dozens of other texts, Jane Marcet's *Conversations on Chemistry* dominated elementary chemical instruction in these academies. Administrators could have chosen texts that emphasized useful applications or spiritual lessons. They chose instead a presentation novel for both its attention to chemical theory and its advocacy of hands-on laboratory instruction for beginners. It was not simply a matter of teaching the principles of baking or soap making. Academy chemistry, at least in those schools that used Marcet's text, was serious chemistry for beginners: an up-to-date review of European chemical theory, illustrated by experiment, requiring an understanding of chemical terminology and facility in the manipulation of laboratory equipment and chemicals.[47]

The popularity of Marcet's book suggests that American educators wanted young women to understand the basics of theoretical and experimental science. Their reasons for this remain unclear. But certainly the instruction offered in the women's academies provided an important initial impetus for changes in the nature of women's participation in science. While the legacy of scientific training in the women's academies is difficult to measure, some women did become prominent scientists in the second half of the century. Wellesley College's first professor of physics, Sarah Frances Whiting, graduated from Ingham University for Women and taught at the Brooklyn Heights Seminary. The naturalist Lydia White Shattuck studied at Mount Holyoke Seminary. The botanist Graceanna Lewis attended the Kimberton Boarding School. The astronomer Maria Mitchell, her student and fellow-astronomer Mary Whitney, the chemist and educator Mary Lyon, the psychologist Christine Ladd-Franklin, and the chemist and home economist Ellen Swallow Richards were also products of this changing educational climate.[48]

The availability of serious scientific education in the new women's academies set the stage for increasing women's involvement in science. The access to introductory science instruction in a formal laboratory setting—rather than through a male family member, or a brother's tutor—legitimated feminine interest in scientific theory. And as the famous Faraday anecdote suggests, the young mind can sometimes reach grand conclusions from rather minor encounters.

[47] The Boston Girls' High School has been credited with being the first school to offer the teaching of chemistry with laboratory instruction, in 1865. By 1871 many high schools had chemistry laboratories. See Sidney Rosen, "The Rise of High School Chemistry in America (to 1920)," *J. Chem. Educ.*, 1956, *33*:627–633, on p. 628.

[48] Warner, "Science Education for Women" (cit. n. 35), pp. 65–66. See Margaret Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore: Johns Hopkins Univ. Press, 1982), for a full discussion of this emergence of women scientists in the mid- and late-nineteenth century.