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The Science Education of American Girls, 1784--1932

by

Kimberley F. Higgins Tolley

B.A. (University of California at Santa Cruz) 1974
M.A. (University of California at Berkeley) 1985

A dissertation submitted in partial satisfaction of the
requirements for the degree of
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in
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in the
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1996
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1996
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Kimberley F. Higgins Tolley
To my mother, Carol Ellis Higgins, 1925-1994
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A number of other scholars provided advice and encouragement along the way: Barbara Beatty, Joan Burstyn,
Roger Geiger, James Albisetti, Jana Nidiffer, and Victoria-Maria MacDonald. I would also like to thank the members of the History of Education Society's Henry Barnard Prize Committee for honoring the second chapter of this dissertation with the Henry Barnard Prize.
Introduction

Over the past several decades, a number of scholars have drawn attention to the relatively poor achievement of American girls in science and mathematics.¹ Many educators and policy makers appear to believe that this state of affairs has always been present in American education. According to one author, "Boys have historically outscored girls in math." Similarly, the American Association for the Advancement of Science reports in a recent document that "In the past, [girls] have largely been bypassed in science and mathematics education."²

The research undertaken for this study reveals a surprisingly different picture. My thesis is that science was a girls' subject in the early nineteenth century. Such historical sources as school catalogs, newspaper advertisements, textbooks, and contemporary accounts reveal that by 1840, a greater percentage of girls' secondary schools offered natural philosophy (physics), astronomy, and chemistry than did comparable institutions for boys. Of course, we know that this situation did not persist throughout the century. As historians have noted, by the 1930s boys outnumbered girls in most science and mathematics courses in private and public secondary schools across the country.³ How and why this shift occurred is the primary puzzle this study seeks to solve.

To date, no published historical study has undertaken a

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comparative analysis of the science education of adolescent boys and girls; nor has any analyzed the evolution of girls' scientific interests from the antebellum era to the twentieth century. As a result, some critical questions have been left unanswered: Why did the various sciences first enter the school curricula available to girls? To what extent were the science studies of girls comparable to those of boys during the early nineteenth century? How can we explain the cultural construction of science as a boys' subject in the twentieth century? By undertaking a comparative investigation of the science schooling of American girls from 1784 to 1932, this dissertation seeks to answer these and other questions.

For the most part the focus here is on students from the ages of 12 to 18, what we now call middle- and secondary-school students, although many of the nineteenth-century educational institutions serving adolescents -- common schools, female seminaries, academies, boarding schools, and the preparatory departments of colleges and universities -- took in pupils as young as eight. During much of the century, classrooms were not age-graded. Students proceeded through various "classes" according to their mastery of the subject matter; as a result, very young students could occasionally be found studying alongside far more mature classmates. The vast majority of these students, male and female, did not go on to college. As late as 1900, only four percent of the 18-21 age group
entered institutions of higher learning, and fewer still completed a full college course.5

Because of the multiple and evolving nature of the educational institutions open to females from 1784 to 1932, this study examines the mathematics and science curricula available to adolescent girls in a variety of settings. The first three chapters focus largely on education as it occurred in the most common form of institutions open to girls during the antebellum period: day schools, boarding schools, female seminaries, common schools, lyceums, and so on. Such institutions generally catered to children of the upper and middle classes, although scholarships and town grants for poor children of high aptitude slightly broadened their student populations in some cases. As the movement to establish free public high schools gained ground after the Civil War, the attention of the following chapters concentrates on these institutions as well, and on the somewhat more socioeconomically diverse population of students attending them.

Throughout the nineteenth century, educators debated how schooling should best fit girls. Contemporary Americans included this within the broader "woman question." It could not be answered without first addressing the larger issue of women's proper role in society. Any inquiry into the schooling of females must therefore also explore this larger political, social and economic context. Thus, the reader will find that the following discussion looks beyond

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schoolrooms to developments in popular culture and in the workplace. The study also investigates the nature and degree of women's participation in science, since this serves as an indication of whether females viewed science as a fruitful area of endeavor.

In addition to contemporary printed material, the research for this project is based on previously neglected archival collections. At Cornell University, the records of the American Nature Study Society, including publications, correspondence, and minutes of meetings, have been carefully collected and preserved by members of the Society, but little used by scholars. Also at Cornell, the papers of nature-study leaders Liberty Hyde Bailey, Anna Comstock, and others include memoranda, correspondence, diaries, lecture notes, and other documents bearing directly on the nature-study movement and on more general developments in nineteenth- and twentieth-century science. Archives at the University of Chicago and at the Wisconsin State Historical Society also furnish a wealth of information about an increasingly male network of professional science educators that gained prominence during the 1920s. The Phi Delta Kappa correspondence in the University of Chicago's College of Education records illuminate practices of discrimination against women and minorities among professional educators at that institution. At Wisconsin, the papers of the well-known science educator Gerald S. Craig are a valuable resource for learning about the organizations of mostly male
science educators that developed and promoted the new elementary science program.

City school records and state superintendents' reports reveal something of the extent to which educational theories are implemented in practice. The collection at Cubberley Library, Stanford University served as an important repository for this study. The library's collection contains reports from every state in the country, dating in some cases from the antebellum period.

Late-eighteenth and nineteenth-century textbooks provide essential information about the content and mathematical complexity of the scientific subjects studied by nineteenth-century boys and girls. For the most part, the books surveyed here are housed in the Special Collections of the Cubberley and Green Libraries of Stanford University; a few texts from the Bancroft Library at the University of California at Berkeley rounded out my sample.

This dissertation begins in 1784, with the appearance of the first American geography schoolbook. The author dedicated his text to "the Masters and Misses of the United States," signaling its appropriateness for females. Like other late-eighteenth century American geography schoolbooks, Jedidiah Morse's book was a compendium of elementary scientific subjects, including geography, natural history, natural philosophy (physics), and astronomy. As the following chapters will demonstrate, the
texts of Morse and other geography others were only the first of many science texts to find their way into the hands of nineteenth-century American girls. Chapter One explores the social, cultural, and economic motives underlying this curricular development.

The second and third chapters undertake a comparative investigation of the scientific studies of girls and boys in private secondary schools during the antebellum period. These schools educated the majority of the nation's secondary students before 1880, and many were single-sex rather than coeducational schools. Chapter Two analyzes the courses of study and examinations of boys' and girls' schools in order to evaluate the degree to which they emphasized scientific subjects. To compare the content and level of difficulty of the sciences available to girls with those offered boys, Chapter Three analyzes samples of textbooks used in male and female institutions.

Two long-standing assumptions about the science education of girls are challenged in Chapters Four and Five. First, it has been suggested that nineteenth-century American girls abandoned the study of the physical sciences because of their mathematical complexity. In order to test this theory, Chapter Four analyzes the evolving mathematics education of American girls from the antebellum period to the end of the nineteenth century and compares the curricula available to girls with that offered their male counterparts. Second, scholars have argued that growing
numbers of young women took up the study of natural history in the nineteenth century largely because of cultural beliefs linking women to nature. Chapter Five tests this theory in light of the evidence provided in several overlooked contemporary sources.

The role of women in science education during the late-nineteenth and twentieth centuries is the subject of the subsequent two chapters. The spotlight shifts from girls to women because during the late-nineteenth and early twentieth centuries, the vast majority of females who studied science in secondary schools and higher institutions did so in order to become teachers. Thus, negative developments affecting this career path would logically have had a direct impact on girls' level of interest and enrollment in scientific subjects. Chapter Six analyzes women's growing participation and leadership in a form of natural-history education known as nature study. The reaction of the male education community against the increasing influence of women in the nature-study movement is the focus of Chapter Seven. This chapter also details the creation of institutional barriers to women's employment and advancement in science education, roadblocks erected by a number of newly-formed professional organizations in the science education community.

Chapter Eight analyzes additional social and curricular developments that contributed to the demise of science as a girls' subject. The first of these, which originated
earlier in the nineteenth century, was the trend among elite girls' schools to emphasize the classics in their curricula as part of an effort to elevate the status of their institutions. The second, which gained momentum at the century's end, was a national movement to include vocational and commercial subjects in secondary schools as part of a larger effort to adjust schooling to the presumed future destinies of boys and girls, especially those of the working classes. The chapter explores the probable effects of these two developments on the science enrollments of girls in secondary schools.

In preceding efforts to recount the history of precollege science education in the United States, some historians have completely ignored developments in female education. This leaves their readers to conclude that the activities of girls and women had little bearing on the historical course of events. In an attempt to redress such omissions, other scholars have erred by focusing on females to the exclusion of males. This strategy leaves unanswered a number of important questions about the extent to which the science education available to girls was comparable to that offered boys. The research undertaken for this study reveals that both of these limited approaches obscure an important interaction. As the following chapters will demonstrate, the form and content of precollege science education developed, in part, as a result of the greater social interaction and often the direct competition of the
two sexes.

Notes


(4) Thomas Woody, A History of Women's Education in the United States, II (New York: The Science Press, 1929), 164. According to Woody, female seminaries varied as to the age of admission, from twelve to sixteen. After 1835, the specified age was usually given as from fourteen to sixteen. Nevertheless, contemporary accounts indicate that younger scholars were occasionally admitted. For example, in a reminiscence of her mother's school, Elizabeth Palmer Peabody recalled that "The qualification for entrance was to read English intelligibly; and her youngest scholars were eight and ten years of age." Quoted in "Letter From Mrs. Elizabeth Palmer Peabody," in The American Journal of Education, 30 (1880): 584.


(6) For example, Scott L. Montgomery, Minds for the Making: The Role of Science in American Education, 1750-1990 (New York: The Guilford Press, 1994); George DeBoer, A History of Ideas in Science Education: Implications for Practice (New...
Chapter 1

Geography Opens the Door

Introduction

Geography was the first science to appear in girls' schoolbooks after the American Revolution. During the colonial period, the ability to read, write, and manage simple accounts comprised the goals of a basic education for free American boys. The Psalter, New Testament, Bible, and such religious books as the New England Primer constituted the texts primarily used in colonial schools. Middle- and upper-class parents desirous of providing a classical training for their sons enrolled them in local Latin grammar schools, where boys studied such additional texts as the Anabasis and the Iliad, either in preparation for college, or to attain the gentlemanly polish necessary to maintain or improve their social status. Because most girls had access only to such informal sources of education as the family and dame schools, their schooling was both rudimentary and haphazard. After the Revolution, however, some parents began to send their daughters to private schoolmasters and newly-founded academies, seminaries, and common schools, where girls studied a more diverse curriculum that usually included the science of geography.

Why did post-colonial Americans seek an expanded education for their daughters? And why did they consider the science of geography an appropriate subject for females?
Several historians of education have argued recently that the introduction of scientific subjects into American educational institutions after the Revolution is evidence of a significant cultural and societal transformation motivated in part by the reforming ideas of Enlightenment thinkers.\textsuperscript{2} To date, however, no published study of science education during the post-colonial period has focused on girls. As a result, scholars have consistently overlooked the fact that the most profound changes in schooling occurred among American daughters rather than sons. Nor can the revolution in female education easily be explained by the long-accepted theory that British and Continental Enlightenment ideas created support in America for the introduction of scientific study; after all, in such countries as France and Germany, important sites of Enlightenment ideas, the education of girls did not follow a similar path.\textsuperscript{3}

This chapter explores the political and societal forces that led Americans to introduce their daughters to the study of the sciences. In order to discover the means by which geography first entered the curriculum, the discussion begins with the publication of the first geography textbooks authored by American citizens after the Revolutionary War.

Revolution and Reform

After the Revolutionary War, Americans faced the enormous task of building a new, independent country. Such leaders as Benjamin Franklin, Thomas Jefferson, Noah Webster, and Benjamin Rush, professor of chemistry at the
University of Pennsylvania, conceived of a complete reformation of American life, a reform based on the Enlightenment ideals of reason and science. "The American War is over," pronounced Rush," but this is far from being the case with the American revolution." Rush argued that the United States required a new educational program particularly suited to the development of an enlightened citizenry in a democracy. Whereas training in the classics constituted the traditional education of the Old World, the new Republic required an innovative educational program, one that included such sciences as geography, natural philosophy, astronomy, natural history and chemistry. The criteria by which Rush claimed to select his subjects was the degree to which they were "accommodated to the present state of society, manners and government of the United States."4

At the end of the war, textbooks at all levels were in fairly short supply. And because they had been written by British and European authors, the existing geography texts in institutions of higher learning were no longer acceptable to Americans, who now required new textbooks reflective of their independent status and social goals. The first author to fill this need was the Reverend Jedidiah Morse, a graduate of Yale University. As Morse rather sharply put it, "We are independent of Great Britain and are no longer to look up to her for a description of our own country."5 In the preface to his hugely popular Geography Made Easy, Morse
proclaimed:

We have humbly received from Great Britain our laws, our manners, our books, and our modes of thinking, and our youth have been educated rather as subjects of the British Kings, than as citizens of a free and independent nation. But the scene is now changed. The revolution has been favorable to science in general, particularly to that of the geography of our own country.

Morse dedicated his first text "To the Young Masters and Misses Throughout the United States," signaling its appropriateness for females. According to several scholars, Morse's books were widely used for several decades. His Geography Made Easy, first published in 1784, ran through numerous editions at least until 1820, when the 23rd edition appeared, and a number of his books were translated into French and German and attained recognition abroad. The earliest rival to compete with Morse was Nathaniel Dwight, who published a small volume of geography questions and answers in 1795. Other well known geographies published before 1810 included J. Goldsmith's An Easy Grammar of Geography, for the Use of Schools, published in Philadelphia in 1804, and John O'Neill's A New and Easy System of Geography and Popular Astronomy, published in Baltimore in 1808.

Initially, the subject was accessible only to a small, relatively elite portion of the American population, because the study of geography required a foundation of literacy. Few Americans attended school at the end of the eighteenth
century. In 1800, the average citizen spent only four months and two days in schools during his or her lifetime -- long enough to learn the letters of the alphabet, write a few words, and calculate the simplest sums. By 1840, the amount of time Americans spent in schoolrooms had expanded to a mere ten months and eight days.9 And in 1842, the Massachusetts educator Horace Mann reported that of the forty thousand poor children in his state, "only one-half [are] attending schools."10 Perhaps in recognition of this state of affairs, in the 1795 edition of Elements of Geography, Jedidiah Morse claimed that his book was not only designed to be used as a reading book in common schools but as a "useful Winter Evening's Entertainment to Young People in Private Families."11

Geography first entered the curricula of middle-class boys in such elite institutions as academies and seminaries. During the eighteenth century, advanced education for males was offered by private schoolmasters and local grammar schools that usually offered instruction in Latin and Greek. As the century progressed, the growth of scattered villages, the division of towns into school districts, and the expansion of district schools accompanied a gradual decline in the number of grammar schools. Advanced instruction was provided by increasing numbers of private schools and incorporated academies established to fill the void.12

Although science had rarely been included in the curricula of the colonial grammar or Latin grammar schools,
a number of early academy charters included geography, astronomy, and natural philosophy among the subjects to be offered, reflecting the newer views on education. The standard studies in the boys' academies generally included the traditional subjects of English, Latin, Greek, declamation, writing, and arithmetic, and some portion of the newer subjects of French, geography, logic, geometry, and natural philosophy or astronomy.\(^\text{13}\)

From an early date, some boys' academies opened their doors to girls, educating females in a separate department. For example, Robert Leeth's school placed an advertisement in the *New York Gazette-Weekly Post Boy* in 1751, offering instruction to both sexes in "two handsome Rooms, with Fire-places, the one for Boys and the other for Girls."\(^\text{14}\)

Near the end of the eighteenth century, a few teachers opened schools exclusively for girls, supporting their efforts financially with funds raised by selling shares. For example, Sarah Pierce opened her school for girls in the dining room of her home in Litchfield, Connecticut, in 1791. Two pupils from her school, Catharine and Mary Beecher, opened the Hartford Female Seminary in 1823. Their school was incorporated in 1827, the same year as the parent school at Litchfield.

Newspaper advertisements published in both northern and southern states during the 1820s reveal a growing number of schools claiming to provide a relatively advanced form of schooling for girls. Such institutions described themselves
variously as female academies or seminaries, day schools, boarding schools, or ladies' select schools. Some institutions enrolled girls from the ages of eight to sixteen or eighteen; others admitted students at age twelve; and some schools, perhaps needing the tuition gained by enrolling additional students, took in any students that applied, even those younger than eight. Because the educational institutions established for girls were so diverse, for the purposes of this study, schools providing instruction beyond learning to read and write are referred to as "secondary schools." Before 1810, the standard studies in girls' secondary schools generally included geography, English, writing, arithmetic, needlework, and several ornamental subjects offered as electives.

During the first decade of the nineteenth century, both male and coeducational secondary schools in northern and southern states included geography in their courses of study. For example, in 1801, a local newspaper published a report of the examinations in the female department of North Carolina's Fayetteville Academy, noting that the young ladies answered questions in "geography, reading, spelling, arithmetic, writing [and] needlework." In 1815, a knowledge of geography was made a condition for entering Harvard College, and by the 1830s, the subject was firmly established in the courses of study offered to boys and girls in the academies and seminaries of such states as Pennsylvania and North Carolina, as shown in Tables 1-2.
By the third decade of the century, geography was also almost universally included in the curricula available to students from a greater variety of classes in common schools (see Table 3). Contemporaries used the term "common school" to refer to an institution under governmental control established for the education of the children of American citizens; increasingly, such schools were also free. At different times during the nineteenth century, each state established its own system of common schools. Massachusetts set up a free school system in 1827, Delaware followed suit in 1829, Pennsylvania in 1834, Vermont in 1850, Indiana in 1851, Ohio in 1853, and Iowa in 1858. By 1832, the textbook author Jesse Olney was able to claim confidently in his preface that "the introduction of Geography into common

Table 1
Percentage of Pennsylvania Secondary Schools Offering Geography, 1750-1889

<table>
<thead>
<tr>
<th></th>
<th>1750-1829</th>
<th>1750-1889</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female Schools</td>
<td>67% (n=36)</td>
<td>83% (n=90)</td>
</tr>
<tr>
<td>Male &amp; Coeducational Schools</td>
<td>74% (n=47)</td>
<td>77% (n=116)</td>
</tr>
</tbody>
</table>

Source: Compiled from Mulhern, A History of Secondary Education in Pennsylvania (New York: Arno Press, 1969), 328 and 428. Mulhern's data is based on the courses of study offered in school catalogs. Sample sizes are indicated in parentheses.
Table 2

Percentage of North Carolina Male and Female Secondary Schools Offering Geography, 1794-1839

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female Schools</td>
<td>94% (n=47)</td>
</tr>
<tr>
<td>Male Schools</td>
<td>86% (n=56)</td>
</tr>
</tbody>
</table>


Table 3

Percentage of Connecticut and Massachusetts Towns Reporting Geography Texts Used in Their Common Schools

<table>
<thead>
<tr>
<th>State</th>
<th>Date</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts</td>
<td>1837 (n=30)</td>
<td>100%</td>
</tr>
<tr>
<td>Connecticut</td>
<td>1846 (n=30)</td>
<td>97%</td>
</tr>
</tbody>
</table>


schools, as a regular branch of education, has of late years become nearly universal".19

In spite of Olney's claim, in fact, the study of geography was not offered to every child in America. In the antebellum South, several states passed legislation outlawing the teaching of slaves.20 And in the North, although some free African-American children studied geography in the few common schools established for their benefit, the quality of instruction provided in such schools was often rudimentary and poor. For example, in their 1845
report, the examining committee of Boston's common schools concluded that the inadequate performance of African American children on the committee's geography examination was due to the deplorable instruction provided in the sole institution set aside for their education.21 "It is to be regretted," reported the committee, "that the present incumbent has not more faith in the desire of the colored population for the education of their children and in the capacities of the children themselves."22 Contemporary reports indicate that conditions in the South after the Civil War were little improved. For instance, Caroline Alfred, a teacher of free African Americans in Columbus Georgia, complained despairingly in 1874 that "in the public colored school in this city great pains are taken that the pupils shall only learn to read."23 In describing the travails of a fellow teacher, Alfred noted the lack of attention in a "colored public school" to even the most basic instruction in geography and arithmetic:

You can judge how it was, for his pupils told him they did not know where their lessons in Geography and Arithmetic were, for it was so long since they had recited.24

Contemporary Rationales for Including Geography in the Curriculum

During the post-colonial period, educators came to associate geography with a broad range of republican values. In order to understand why American citizens believed that
the subject should be taught to their daughters as well as their sons, it is necessary to consider the underlying issues that structured this curricular debate. As described by contemporaries, the principal advantages offered by the study of geography fell into three general categories: utility, morality, and citizenship.

The study of geography was important to Americans for reasons of economic and national utility. During the opening decades of the nineteenth century, the economic expansion of the country, the opening of the West, the development of industry, navigation, transportation, mining, and agriculture, all increased the perceived and practical needs for a greater knowledge of the nature and resources of this still largely unexplored nation. How did the country look on the map? What treasures were buried beneath its mountains and plains, under its lakes and rivers, hidden in its great forests? This post-revolutionary period was a time of intense interest in geography and other scientific and technological subjects. Such new organizations as lyceums, societies, and research institutions sprang up to investigate these various fields, and wealthy patrons contributed time and money for the promotion of expeditions and surveys of rivers, coasts, mountains, and plains.25

Of great concern to early American scientists and educators was the need to develop American expertise in the sciences and mechanical arts. During the first decades after the American Revolution, when elementary textbooks
devoted to astronomy, natural philosophy, or natural history had yet to be published in significant numbers, geography textbooks introduced American schoolchildren to the subjects of astronomy, natural history, physical geography, and natural philosophy, subjects deemed necessary to the promotion of the young nation's "flourishing and improving condition." According to Horace Mann, education was the means by which a new generation of inventors and scientists would thrive:

If among ten well-educated children, the chance is that at least one of them will originate some new and useful process in the arts, or will discover some new scientific principle, or some new application of one, then, among a hundred such well-educated children, there is a moral certainty that there will be more than ten such originators or discoverers of new utilities; for the action of the mind is like the action of fire.

Reflecting national priorities, early nineteenth-century popular magazines published for children often included articles on geography and natural history. First issued in the United States in 1827, The Youth's Companion claimed "to be instructive as well as entertaining," and contained natural history subjects along with moralistic tales and religious poetry. Magazines created to improve and instruct the young had long been popular in Great Britain, where such periodicals as The Juvenile Magazine, first published in 1788, and the Youth's Monthly Visitor, published briefly in 1822, had regularly mixed an assortment of morally uplifting fiction with samples of botany,
metallurgy, astronomy, and geography. Popular in the United States, the British periodical *Children's Friend, or Sunday Scholar's Reward* regularly included articles on geography and botany.²⁹

According to the historian Kristen Drotner, the expansion of secular periodicals for British children in the 1830s and 1840s was the direct result of the North American influence for the pursuit of useful knowledge. In 1833, the American geography author Samuel Goodrich launched the *Peter Parley* magazine in the United States, a periodical that featured articles on geography, natural history, geology, and astronomy. Goodrich's magazine far surpassed its competitors in the wealth of detail it provided about the height, duration, distance, or weight of natural phenomena. Imitations and spinoffs of Goodrich's magazine quickly appeared in Great Britain, and at one time there appear to have been at least six different *Peter Parleys*.³⁰

During an era when the ranks of botanists, geologists, and mineralogists were swelled with enthusiastic amateurs and supporters of natural history, even the explorations of children could contribute to the advancement of scientific knowledge. The earliest geographies introduced young students in a rudimentary way to the subjects of geology and mineralogy, subjects held to be useful because of their potential economic benefit to the nation:

Their pockets, shelves, and chambers, which are soon loaded with specimens, afford the most satisfactory proof of their industry, as well as
of their interest and knowledge in this practical science. The researchers of these young explorers have not unfrequently been rewarded with valuable discoveries, not merely to enrich their collections, but to increase the wealth of the country, and to advance the useful arts.31

Assisting in the promotion of a popular enthusiasm for science, several schoolbook authors stressed the entertainment value of geography. Of geography schoolbook authors, it was Jedidiah Morse, more than any other, who first brought Americans a taste of the adventure found in the natural world: exciting views of far-off lands, tales of such exotic animals as the woolly mammoth, strange animals reported to inhabit the unknown regions of the lower Mississippi, and news of thrilling scientific discoveries. From Morse, Americans learned about the vast and still unexplored areas of the North American continent. He beckoned young explorers with intriguing descriptions of such geographical features as the "Shining Mountains lying away west of the Mississippi, but little known."32

Such later authors as Jesse Olney and Samuel Goodrich also added spice to their descriptions of natural phenomena. Goodrich must have captivated young audiences with his description of glaciers, in which "a thousand spires glitter in the sunshine...vast pyramids and obelisks are presented to the astonished beholder."33 At least one contemporary writer assumed that the impact of these fascinating passages on schoolchildren was enormous. Fifty years after the publication of Olney's geography, a writer in The Youth's
Companion reminded his readers of an illustration that had appeared in Olney's text, confident that everyone of a certain age would remember it:

Those who studied Olney's geography fifty years ago, can doubtless recall the picture that illustrated the description of Brazil. It depicted a white man riding on the back of an alligator, which a dozen natives were hauling on shore. 4

From the first geography published in 1784, every textbook provided American schoolchildren with some accounts of the "mineral treasures of North America," which, "so far as discovered, are chiefly confined to coal, iron, copper, lead, silver, and gold." Such passages provided tantalizing views of known resources and unknown treasures yet to find. During the first decades of the nineteenth century, Americans eagerly sought mineral resources. Public support for financing discovery was crucial to the success of geological surveys. The first geologic survey in America financed at public expense was begun by the state of North Carolina in 1823. Similar surveys were begun by South Carolina (1824), Massachusetts (1830), Tennessee (1831), New Jersey (1835), and Georgia, Maine, and New York (1836). 35 The popularization of geography and other scientific subjects through such media as schoolbooks and magazines probably enhanced public support for the financing of local expeditions and surveys and for scientific activity in general.

In addition to promoting useful knowledge and
popularizing science, Americans viewed geography as a subject particularly capable of promoting moral and religious development. Late-eighteenth and early nineteenth-century American educators believed that moral education was a primal necessity of social existence, because, in the words of Horace Mann, "a community without a conscience would soon extinguish itself." Reflecting similar values, schoolbook authors filled their primers and spelling books with moral homilies calculated to lead young minds along the paths of virtue. For instance, numerous editions of the New England Primer contained such religious admonitions as: "Liars shall have their part in the Lake which burns with Fire and Brimstone."37

With the popularization of natural theology in the United States, the study of the natural world became morally uplifting. Natural theology, which gained popularity at the beginning of the eighteenth century in Great Britain, was founded on the premise that God could be known by consulting either Scripture or nature itself, both of which led to the same truths. Central to natural theology was the argument of design, in which the mechanism, instrumentality, or design in nature attested to the existence of an intelligent and benevolent Creator. From the beginning of the eighteenth century, English natural philosophers published a stream of books aiming to reveal the wonders of God's creation through the natural sciences, from the naturalist John Ray's highly popular The Wisdom of
God in the Creation (1691) to William Paley's Natural Theology (1802). In newspapers published just after the American Revolution, popular titles in natural theology can be found alongside the titles of the latest novels in the advertisements of local booksellers.38

As the chronicler of natural history Lynn Barber has noted, natural theology made the natural world the site of knowledge about God. In Natural Theology, Paley argued that just as, in admiring a well-made watch, we are led to admire the skill of the watch-maker who created it, so, in admiring the natural world, we are inevitably led to think of its Creator. The more we learn to understand and appreciate God's Design in Nature, the more we grow in knowledge of God.39

Imported from abroad, natural theology found fertile soil in the United States in the early nineteenth century, a period when religious movements swept the nation. Some church groups promoted the study of the natural world for its presumed theological benefits.40 For example, in the 1830s, when the American Sunday School Union began offering Sunday school libraries for sale to common schools, its collections included maps and volumes on natural history and travel.41

Female educators promoted geography as a vehicle for the moral improvement of girls and women. For example, in her influential Strictures on Female Education (1799), writer Hannah More suggested geography as a subject for
moral instruction.\textsuperscript{42} In the preface to her highly popular \textit{Geography for Beginners}, Emma Willard, the eminent founder of Troy Female Seminary, recommended the study of geography as a means of gaining knowledge of God:

The study of geography may lead your mind to pious reflections bringing to your view the power, wisdom, and goodness of God...all these are the workmanship of His Hands, whose creatures we are...while we contemplate them, we shall learn to adore him.\textsuperscript{43}

In addition to its presumed moral benefits, geography also met the needs of educators looking for a subject capable of strengthening the mental discipline of American schoolchildren. As citizens of a new political experiment, there were new requirements for young Americans. For Americans faced with the task of building a nation on democratic principles, the development of an enlightened, rational citizenry was the key to a successful republic. The task of creating an educational system and a curriculum capable of molding children into enlightened citizens became a political imperative.\textsuperscript{44}

The ability of a particular subject to promote mental discipline, to strengthen the faculties of the mind, was of utmost importance to educators. More than any other subject in the school curriculum, its authors argued, geography would develop the student's reasoning ability. Drawing maps would "fix the wayward attention of children." Altering the scale in drawings would "exercise the power of judgment to a degree of which few studies are capable," and learning
geographical facts would "exercise the memory." Early textbook authors extolled the virtues of geography as a rigorous study for both sexes, often contrasting it with such trivial pursuits as top-spinning or hair curling. In the preface to their geography published in 1818, Vinson and Mann warned parents of the dangers of encouraging their girls to decorate dolls and of allowing their boys too much time for idle play:

The parent, who is contented merely with emulating a son by the spinning of a top...or, a daughter by learning her to decorate a doll, to curl her hair...must not be surprised nor disappointed if he discovers no higher, no purer emotions in their bosoms, and ideas in their minds...46

In contrasting the study of geography with such frivolous pursuits as doll play, Americans evidenced the beginnings of an educational agenda quite distinct from that of France, a country that served as an important source of Enlightenment ideas. According to the historian Rebecca Rogers, with few exceptions the content of girls' education in France from the Revolution until the latter half of the nineteenth century stressed religion, reading, writing, and such ornamental subjects as music and drawing. Although women's amateur scientific interests were encouraged, Rogers surmises that Jean-Jacques Rousseau's *Emile* (1762) largely shaped French views of women's education, stressing women's need for an essentially domestic education in which young girls learned to please men and become good mothers.47
In addition to promoting useful knowledge, moral virtue, mental discipline, and developing a public supportive of scientific enterprise, the study of geography met the political needs of the new country as well. The attention of students to the geographical features of the United States, particularly when described by its own citizens, could instill national pride. Like the authors of reading and spelling books, authors of geography schoolbooks aimed to develop the child's loyalty to the state. Every geography contrasted monarchy to republicanism, seen as the perfect vehicle of liberty in the United States:

This Constitution, principally from the pen of Thomas Jefferson, more happily embraces the equal rights and liberties of man, than any other system on the globe.48

The authors of geography schoolbooks sought to generate national ideals and define those attitudes and behavior deemed proper for American youth. One means of doing so was to contrast the national character of the allegedly more virtuous United States with that of foreign countries. Geography authors claimed that each nation could be recognized by its own peculiar and inherited traits of personality and intellect. For example, Morse characterized the Irish as ignorant and volatile, a "blundering sort of people; impatient of abuse and injury; implacable, and violent in their affections; quick of apprehension..."49

Similarly, many authors presented unfavorable portraits of
other Catholic countries, including Spain, Italy, and France. Historians have described in detail the negative depictions in geography schoolbooks of countries whose government, religion, or race differed from that of the United States. In contrast, geography schoolbooks presented American institutions and character as representing the hope of all mankind. Americans were "generally industrious, intelligent, and enterprising." Americans "[knew] how, at proper times to be liberal, and [were] ever ready to assist the unfortunate." One geography author, using the cathectical method, posed this typical question and answer:

Q. What is the national character of the United States?  
A. More elevated and refined than that of any nation on earth.

A number of scholars have theorized that the sciences entered the curriculum in response to the kinds of social, political, and economic needs discussed above, including the demand for skilled workers in the mechanic arts. But how did these needs and demands justify the study of geography among females? After all, women could not vote. Nor did early nineteenth-century Americans expect their daughters to become practicing geographers, mechanics, navigators, or surveyors; the social and cultural mores of the period largely restricted the sphere of women's influence to the home.

It is likely that Americans promoted science among girls because in the newly-independent United States,
women's help was required to promote science and develop scientific interests among young children. In contrast to such countries as England or France, which had well-established, if still largely amateur scientific traditions, the fledgling United States faced the daunting task of building a scientific community largely from scratch. Potential scientific talent lay among children, the majority of whom received their schooling from family members at home. Thus, many post-colonial Americans were acutely aware of women's important social role as teachers of the young. According to historian Thomas Woody, during the early nineteenth century, Americans of both high and low estate expressed the view, through private letters, speeches, sermons, and periodicals, that women must be better educated to fill their domestic role. In a "letter from a father to his daughter," published in the Charleston Observer, one writer echoed the prevailing opinion of that era:

The mother is ever before the mind, and when the pride of intellect has transported the man in maturity beyond the influence of even sound argument and rational conviction, he remembers the lessons of that mother and feels their truth.54

Another compelling rationale for educating females was based on the belief that men and women's increased mental faculties were transmitted to their offspring through inheritance, thereby improving the intellectual and creative abilities of subsequent generations. This belief was based
on the views of eighteenth-century naturalist Jean Baptiste Antoine de Monet, Chevalier de Lamarck. The evolutionary theory of Lamarck proposed a predetermined path by which life progressed from simpler to more complex forms. According to Lamarck and his followers, the natural environment created a variety of needs that each animal used its body to fulfill. Over time, the effect of exercise, of use or disuse, caused some body parts to develop and others to degenerate. Lamarck assumed that the characteristics acquired as the result of effort would be transmitted to the animal's offspring, thereby enabling the effect to become cumulative.55

Early nineteenth-century Americans viewed the human mind as comprised of a carefully detailed hierarchy of faculties capable of being improved through "mental discipline." Just as the muscles of the body could be strengthened through rigorous and repeated use, so the mental faculties, the muscles of the mind, could be trained through properly directed mental exercise. Such American Lamarckians as paleontologist Edward Drinker Cope argued that Lamarckism allowed living things to be in charge of their own destiny. Through an ideal educational program, one which developed and strengthened the mental faculties, humans could artificially direct the characteristics of future generations, thereby accelerating progress towards the Creator's ultimate goal.56

In his efforts to build popular support for the
common-school movement in New England during the 1840s, the eminent educator Horace Mann disseminated views similar to those of Lamarck and his followers. According to Mann, the American experiment of offering children free public education would result in enormous social benefits due to the resulting improved mental faculties of the population. "In the whole of the past history of the world," he claimed, "no generation has yet existed, whose faculties have not, to a very great extent, lain dormant," --- a state of affairs that the new experiment in mass education was soon to reverse.57 Through his public speeches and annual reports as Secretary of the Massachusetts board of education during the 1840s, Mann espoused a glorious vision in which each succeeding generation of Americans, through education, progressed to ever greater heights of intellect and achievement:

The greater the proportion of minds in any community which are educated, and the more thorough and complete the education which is given them, the more rapidly, through these sublime stages of progress, will that community advance in all the means of enjoyment and elevation, and the more will it outstrip and outshine its less educated neighbors.58

During her visit to the United States during the forties, Swedish commentator Fredrika Bremer conversed with Mann about his belief that the mental gains achieved by one generation could be passed to the next through inheritance. According to Bremer, "Horace Mann talks on this subject with a faith which might move mountains."59
As a vehicle for enhancing the general intelligence of the population, promoting moral development, and disseminating useful knowledge, geography securely established itself in the curricula of most private and common schools during the first decades of the nineteenth century. As we have seen, such Enlightenment ideas as natural theology, mental discipline, and Lamarkian views of inheritance served as a fertile source for the rhetoric of those who sought to introduce geography and other scientific subjects into American schoolrooms. Nevertheless, more important than intellectual factors were the unique social, economic, and political context of the young republic. The relatively limited impact of institutionalized schooling and the rudimentary nature of America's scientific community, coupled with the expanding political, economic and technological needs of the growing nation, induced Americans to promote the study of geography among their daughters as well as their sons.

The Content and Method of Some Early Geography Texts

What sort of science might young girls and boys have learned from their geography schoolbooks? The geography as it appears today in American schoolrooms bears only a feeble resemblance to the subject that entered the curriculum after the Revolution. At the end of the eighteenth century, schoolroom geography comprised the branches of physical, political, and astronomical geography. In contrast, the
subject today has largely constricted to political geography and is almost wholly subsumed within the social studies. Relatively little attention has been given to the scientific subjects in early geography texts, because most historians of the curriculum have looked to schoolbooks to locate evidence of contemporary social and cultural values and beliefs rather than to analyze science content. But in many cases, early texts served as compendiums of useful, albeit elementary information calculated, in the words of one author, to disseminate "through every class of society, the illuminating rays of science."60

The earliest geographies published in the United States often included some discussion of such related subjects as natural history, astronomy, and natural philosophy.61 At the end of the Enlightenment, natural philosophy (delimited and later called physics) was an enormous category, including both living and nonliving phenomena. Medicine and physiology, as well as the study of heat, magnetism, optics, and mechanics were part of natural philosophy. The modern sciences of zoology, botany, geology, and meteorology were usually subsumed under natural history. Natural history denoted an investigation into nature, covering the entire range of observable forms from limestone formations to plants.62

Jedidiah Morse provided his readers with an overview of the history of science. In his Elements of Geography, Morse introduced Americans to the discoveries of the great men of
science, from Thales, Pythagoras, and Democritus, to
Copernicus, Kepler, Galileo, and Newton, and finally to the
relatively recent contributions of such scientists as
Herschel and Boyle. Morse included notes in his text
recommending contemporary works:

And I would recommend to you also M. Buffon's
Natural History abridged, p. 31-33 where you
will find an account of many very wonderful
effects of earthquakes.63

In an attempt to develop American pride in American
products, Morse was scrupulous to bring to the attention of
his readers the accomplishments of local scientists as well.
For instance, during a discussion of the air pump, he noted
that "The air pump is a machine..improved by Boyle and
others, in England, and lately by the Rev. Dr. Prince, of
Salem, Massachusetts."64

A knowledge of astronomy was indispensable to the
geographer, and many of the geographies published between
1784 and 1850 included a short section on this science.65
The earliest textbooks were published in New England, whose
coastal towns and villages depended largely on the sea for
their livelihood. Astronomy was central to navigation, a
skill highly valued in coastal communities. Besides
navigation, astronomy was utilitarian for another reason:
while town lots could be surveyed by those with a knowledge
of elementary mathematics, the marking off of provincial
boundaries and the laying out of large blocks of land
required astronomy.66

37
Geography texts introduced students to the structure of the solar system and the orbits of its planets and comets, the relation of the earth's orbit to seasonal change, and the methods of reckoning latitude and longitude. Some texts included more advanced topics, such as the use of a quadrant of altitude to calculate the distance of any two places on the globe, the reckoning of the latitude and longitude of any given star, or the calculation of the time, from conjunction to conjunction, of any two planets.

Besides astronomy, most early geographies included sections on physical geography. Textbook authors defined physical geography as embracing "a view of the sea, the atmosphere, the structure of the earth, together with its rivers, lakes, mountains, minerals, vegetables, and animals." In their discussion of each geographic region, authors commonly included information about its natural history. For instance, in the section on the United States in the first revised edition of Geography Made Easy, published in 1809, Morse included a long inventory of the animals, birds, snakes, and fishes reported to be indigenous to North America.

In addition to the subjects of astronomy and physical geography, textbooks like John O'Neill's A New and Easy System of Geography, included topics in natural philosophy. O'Neill's text included nine chapters "on some of the most important subjects in Natural Philosophy," including such topics as the barometer, thermometer, and hygrometer, the
ascent of vapors, the component parts of the earth, and air.72 Similarly, Jedidiah Morse's Geography Made Easy included sections on magnetism, gravitation, electricity, and heat.73

Geography textbooks published during later decades seem to have devoted less space to scientific subjects than did the early texts of such authors as Jedidiah Morse and John O'Neill. For example, during the 1830s and 1840s, the astronomy included in many books constricted to several lines of questions and answers, as illustrated by the following excerpt from Jesse Olney's widely-used text, published in 1833:

Q. What is Astronomy?
A. It is the science which teaches the motions and the magnitudes of the heavenly bodies.74

The decrease in the amount of astronomy, natural philosophy, and natural history in geography texts published during the 1830s and 1840s may be explained by the rise of textbooks devoted exclusively to these subjects during the same period. As these subjects, along with chemistry, declined in geographies, they began to expand in the curricula of common schools, academies, and seminaries, a phenomenon I shall discuss in detail in the following chapter.

Two other factors may also have influenced the decrease in some scientific subjects in later geography texts. First, the 1830s saw the appearance of geography textbooks
written specifically for younger students, such as the enormously popular geographies of Jesse Olney and Peter Parley, a.k.a. Samuel G. Goodrich. Such texts included little scientific content, perhaps because it was considered too advanced for young children. Second, the increase in the coverage of the cultural, political, and historical background of the nation's various regions may have been in response to the more parochial desire of the citizens in various states to include more information about their local politics and history. During the decades preceding the Civil War, many leading Southerners expressed their displeasure with textbooks authored by Northerners. Two geography authors that were the targets of frequent attacks were Jedidiah Morse and Samuel Goodrich, author of the Peter Parley books. Morse was criticized for prejudice against Southern culture, and Goodrich for including statements viewed as critical of slavery.75 One writer from Georgia complained about the inclusion of natural history at the expense of regional information:

We depend upon Boston publications for our... geographies, and there can consequently be no surprise expressed that our youth grow up with a knowledge of the fact that "immense rattlesnakes can be found in the Okenfenokee swamp," but with very imperfect geographical or historical information about Georgia.76

In their focus on the natural theology and sometimes outdated scientific content of many geography schoolbooks, some historians have concluded that textbook writers were
inherently conservative, religious, and woefully out of touch with the scientific issues of the day. While such a portrayal may be accurate in the main, there are some noteworthy exceptions.

While it may have provided a compelling rationale for the study of geography, the doctrine of natural theology occupied only an incidental place in the content of geography schoolbooks published after the Revolution. William Paley's argument of design in *Natural Theology* was so familiar, that most authors simply invoked it, rather than expounding at length. An occasional reference to Design and the Creator, usually located in the preface, but occasionally sprinkled here and there throughout the text, was enough to cast a pious aura over any geography. Jedidiah Morse prefaced his *Elements of Geography* with a statement of natural theology fairly typical of the geographies during this period:

The first branch of this Science, viz Astronomical Geography, as treated in this little book, furnishes the young Pupil with such a general knowledge of the heavenly bodies, as will facilitate his acquaintance with Geography, and elevate and enlarge his views of the wisdom, power, and greatness of the CREATOR.77

When such expressions of natural theology occurred in the texts of geographies, they usually directed the student's attention to incidents of Design. For example, it was not uncommon for authors of geographies to present the natural world as having been created for humans, thus standing as
evidence of the benevolence of God:

82. The Earth was formed by the Creator to be the abode of man.
83. The land is made for his habitation--the sea for his reservoir of water and highway over the world--and the atmosphere to give him breath.78

Although natural theology probably served to maintain conventional religious views, more speculative fancies were permissible under its protective mantle. Jedediah Morse's geographies introduced scientific subjects, tales of natural wonders, and even a modicum of science fiction into the curriculum in the decades following the American Revolution. In the 1795 edition of his Elements of Geography, God is shown actively involved in the maintenance of His creation, a creation that might even include life on other planets:

To suppose all these stars to be suns, with planets revolving round them like those in our system, as these again revolving round one common centre, a system of systems, and all filled with inhabitants, how does the mind explode with a pleasing amazement at the grandeur of GOD, who created, supports, governs, and minutely and continually inspects the immense whole?79

The natural theology of most textbook authors led them to uphold the belief that the true history of the earth came from the book of Genesis. This view was also not uncommon among members of the geological community before 1835, many of whom were ministers. In his Universal History, Samuel G. Goodrich upheld the biblical account of the creation of the world, an approach fairly typical of the geography textbooks
of this period:

Let us now go back to the creation of the world. This wonderful event took place about six thousand years ago. The story of it is beautifully told in the first chapter of Genesis. 80

Nevertheless, while geography texts, like other schoolbooks, functioned to preserve traditional beliefs and values, certain geography authors introduced geological evidence that may have tended to undermine tradition.

In their sections on physical geography, some writers included discussion of the origin and age of the earth, issues that were still the subject of heated debates within the geological community well after the publication in 1830-1833 of Charles Lyell's Principles of Geology. Lyell theorized that all of the features of the earth could be accounted for by geological processes observable today, a position that was anathema to those intent on upholding Bishop Ussher's date of creation at 4004 B.C. 81

While upholding the Genesis account of the creation of the world, the same schoolbooks taught American children that the earth had existed for many ages, and that its features had undergone many changes. Certain geographies published before 1835 described the stratified appearance of the earth's crust:

To whatever depth excavations have been made in different countries, they have uniformly shown that the solid parts of the earth are composed of strata, or layers of earth, and rock of different kinds. 82
In an attempt to characterize geography schoolbooks as "guardians of tradition," the historian Ruth Elson has claimed that no geography schoolbook published before 1859 mentions the existence of fossil remains discovered some fifty years earlier.\(^8\) While Elson is probably correct in her assessment of the overall conservatism of most geography schoolbooks, at least two prominent and widely read authors did indeed introduce American schoolchildren to the notion that some of the earth's species had become extinct. An 1806 edition of Morse's *Geography Made Easy* describes the woolly mammoth as an "unknown animal, whose bones are found in the northern parts of both the old and new world" and whose "bones prove them to have been 5 or 6 times as large [as an elephant]."\(^4\) Going even further, Samuel Goodrich's 1832 *Malte-brun Geography* informed students that "whole races of animals" had become extinct:

> An almost complete skeleton of an animal several times larger than the elephant, was dug up a few years since near Newburgh in the State of New York, and is now preserved in the Museum in Philadelphia. The bones of animals still larger have also been discovered. It appears probable that, at a very remote period, whole races of animals, different from any existing in any part of the world, and far surpassing the elephant and rhinoceros [sic] in magnitude, once roamed the forests of North America.\(^5\)

The concept of extinction, introduced to schoolchildren by Morse and Goodrich, may have been potentially disruptive of the short history of humankind promoted by Bishop Ussher and others. One might even argue, whether it was intended
by its authors or not, that the concept of extinction, along with depictions of the stratified appearance of the earth, served to undermine, rather than support, conservative ideas. Certainly some contemporaries found such ideas exceedingly dangerous. Through the years of 1852 to 1854, more than fifty years after Jedidiah Morse introduced the concept of extinction in *Geography Made Easy*, the editor of the *Theological and Literary Journal* wrote and published a series of articles against contemporary geology. The editor argued that "the theory generally entertained by geologists respecting the great age of the earth would, if founded on just grounds, disprove the inspiration of the Bible."86

The natural theology in geography textbooks made the study of geography virtually a pious duty. As such, it may have helped to allay the apprehensions of parents and others in the community, who might otherwise have questioned the new subjects and unsettling scientific ideas introduced into the curriculum for their daughters and sons. Its emphasis on traditional religious values perhaps helped newly independent Americans adapt to the gradual transformation of the school curriculum, a curricular revolution completed within the lifespan of a single generation.

In the prefaces of geography textbooks we can find the outlines of initial American debates over the best pedagogical methods for teaching scientific subjects to schoolchildren. Authors argued with each other in their prefaces over the best means by which to introduce their
subject. Several popular authors modeled their books on the cathetical portion of the New England Primer. The following passage from Roswell Smith's 1845 text serves as a typical example of the cathetical method:

Q. What are these divisions called?
A. Natural divisions.
Q. Why are they so called?
A. Because they are not made by man but exist in nature.87

In many cases, entire textbooks were written as a series of short questions and answers.88 This method, however, became the target of such influential authors as Jedidiah Morse, William C. Woodbridge, and Emma Willard.89 Its opponents argued that the cathetical method led to an overemphasis on memorization and recitation at the expense of higher reflection:

Stultifying methods...which impair, instead of improving, those habits of observation and reflection on which the success of the pupil in study, and in future life, depends.90

In spite of spirited opposition, cathetical texts by such authors as Jesse Olney and Peter Parley (a.k.a. Samuel Goodrich) were widely used in the 1830s and 1840s in the common schools of Massachusetts and Connecticut, as shown below in Table 4.
Table 4

Geography Texts Most Commonly Reported in the Common School Returns of Massachusetts and Connecticut

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<th>Massachusetts (1837)</th>
<th>Connecticut (1846)</th>
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<tr>
<td>Olney</td>
<td>79%</td>
<td>Smith</td>
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<tr>
<td>Parley</td>
<td>45%</td>
<td>Olney</td>
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<tr>
<td>Maltebrun</td>
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<td>Parley</td>
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<td>Smith</td>
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<td>Mitchell</td>
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In 1831, one teacher reported that Nathaniel Dwight's cathectical text was even used as a reader in common schools, perhaps because of the brevity of its sentence structure.91

Another methodological debate waged among geography authors involved the respective merits of the inductive or deductive methods of teaching the subject. William C. Woodbridge and Emma Willard are generally credited by scholars with introducing the inductive method of teaching into geography textbooks. Woodbridge first taught geography and other subjects in a young ladies' school in New Haven while a senior at Yale College in 1779. He later became principal of the Medford Female Seminary; in the 1830s he assumed the editorship of the educational journal, the American Annals of Education and Instruction. Collaborating with Woodbridge on several geography texts was the widely
known female educator Emma Willard, the principal of Troy Female Seminary in New York. Their first *Rudiments of Geography* was advertised in 1821, and later revisions were also published in France.92

The inductive method of teaching geography began with the study of the student's home town. Advocates of the inductive method argued that "the learner must make himself master of simple things, before he can understand those which are complex."93 This reversed the deductive procedure used by a number of early authors, who began their texts with celestial geography or the geography of Europe. Emma Willard described the method very simply:

> Instead of commencing the study of maps with the map of the world, which is the most difficult to understand, the pupil here begins, in the most simple manner imaginable, to draw the map of his own town.94

The innovative inductive method of Woodbridge and Willard was rapidly embraced by many of the most popular authors of geographies who published during and after the 1820s.95

The geography textbooks published during the first two decades of the nineteenth century represented one of the few means by which school teachers gained access to new pedagogical skills. The earliest popular pedagogical textbook of the later period, *Lectures on Schoolkeeping*, by Samuel Read Hall, was not published until 1829, and the first public normal school, at Lexington, Massachusetts, did not open until 1839. Many geography authors therefore
included a section addressed to teachers, in which they explicitly introduced the methods and merits of inductive teaching:

Begin, therefore, with giving your pupil as distinct ideas as possible of the things represented... Lead him to observe and describe what he sees—to give him a sort of geographical account of the place in which he lives, and the objects around him; and he will be better prepared to understand the language of Geography.96

According to the historian John Nietz, the inductive method of American geography authors was based on the plan advocated by the famous Swiss educator, Johann Pestalozzi (1746-1827), who referred to it as the "Home Geography" approach. However, it is difficult to evaluate the extent to which Pestalozzi influenced the writings of Woodbridge and Willard, particularly in light of the fact that each author claimed to have originated his or her method independently of any outside influences.

Woodbridge and Willard's popular books were soon followed by a proliferation of geography schoolbooks organized according to the inductive method. However, as interpreted by most early nineteenth century geography authors, the inductive method was a far cry from the direct observation of nature advocated by Woodbridge and Willard. Rather than describing outdoor excursions in which the student might learn geography at first hand, American authors simply began the study of the subject with a list of questions about the students' home town. For example,
Samuel S. Goodrich began his first lesson by asking, "What place do you live in? Is it a town or a city you live in?"97

Whether directly influenced by Pestalozzi or not, the inductive method developed by Woodbridge and Willard and embraced to some degree by subsequent generations of textbook authors probably paved the way for the later reception of object teaching and nature study, pedagogical methods derived from the work of Pestalozzi. Some scholars have argued that object teaching, which involved using objects from the child's environment in instruction, was highly popular with classroom teachers across the country during the second half of the nineteenth century.98 If so, this may be due to the efforts of earlier generations of geography authors, who long since had argued that the child's natural environment was the logical starting place for learning.

Conclusion

The introduction of geography into post-colonial schoolrooms marked an important shift in the way Americans began to think about the education of their daughters. Science and the inductive method of learning entered the curriculum of these schools through the medium of geography textbooks, whose content usually contained a variety of scientific subjects and whose prefaces often included prescriptions for pedagogical method.
The knowledge deemed valuable by a given society inevitably enters the curriculum formally taught to its young people. The courses of study of academies, seminaries, and common schools newly established in the first half of the nineteenth century quickly evidenced the changing priorities of American society. The curricula of institutions of higher learning founded during the colonial period undoubtedly changed more slowly, for reasons that may have included the conservatism of their trustees, the charge of their original charters, the wishes of their benefactors and alumnae, and the general inertia of their established procedures and routines. But these venerable institutions changed too, inevitably opening their doors wider to science. The publication of the first American geography in 1784 marked the beginning of an educational era that would last into the second decade of the twentieth century. Its hallmarks were a fervent belief in the utilitarian and political benefits of reason and science, and a faith that the moral character of young Americans, male and female, would be improved by the study of the natural world.

Although educators drew frequently on the ideas of Enlightenment thinkers to justify their reforms, Americans' response to a new and changing political, social, and physical environment was a far greater factor in shaping the form and content of female education than was the influence of Enlightenment ideals alone. To ensure the success of their new political experiment, Americans required the
assistance of both sexes. As mothers and teachers, women played an important role in providing the moral and intellectual training required of young citizens in a new republic. Additionally, by educating females, Americans believed that they ensured the transmission of important mental improvements to subsequent generations.

Through schoolroom geography, science became an acceptable part of the education of American girls. As the nineteenth century progressed, textbooks devoted exclusively to such subjects as botany, astronomy, and natural philosophy appeared in secondary schools and diminished in geography textbooks, where they were redundant. Although scientific content declined in later geography texts, however, it did not disappear from the curriculum available to females. In the decades to come, increasing numbers of girls would take up the study of science in their secondary schools.

Notes


(5) Quoted in Brooke Hindle, The Pursuit of Science in Revolutionary America, 222.

(6) Jedidiah Morse, Geography Made Easy (Boston: J.T. Buckingham, 1806), v-vi.

(7) Ibid., title page.


(11) Morse, Elements of Geography, 1795: title page.


(16) Ibid., 3.

(17) *North Carolina Schools and Academies 1790-1840: A Documentary History*, ed. Charles L. Coon (Raleigh: Edwards & Broughton, 1915). See the newspaper advertisements for the following male academies: Pittsborough Academy (1800), 35; Hillsborough Academy (1801), 280; Caswell Academy (1802), 18; Franklin Academy (1804), 84; Edenton Academy (1805), 326; Hyco Academy (1805), 22-3; Salisbury Academy (1807), 346-7; Kilpatrick's School (1809), 382. Several North Carolina female academies or seminaries also offered geography during the first decade of the nineteenth century: Fayetteville Academy, Female Department (1801), 60-1; Raleigh Academy, Female Department (1806), 396; Mordecai's Female Seminary (1808), 595; Mrs. Milligan's School (1807), 229; Mrs. Gregory's Boarding School (1808), 295.


(19) Elson, *Guardians of Tradition*, 5-6; The universality of geography as a subject in common schools was also noted by Lemuel Shattuck in his article, "Improvements in our Common Schools," published in the *American Annals of Education and Instruction* (Oct., Nov., 1831): 138.


(22) Quoted in ibid., 185-6.


(24) Ibid., letter dated "Wednesday morning," 1874.


(28) Quoted in Mott, A History of American Magazines 2, 263.

(29) Kristen Drotner, English Children and Their Magazines, 1751-1945 (New Haven: Yale University Press, 1988), 57. Drotner states that nonfictional entries, including those on natural history, occupied more than half the space of juvenile magazines published in Great Britain in the first half of the nineteenth century.

(30) Ibid., 63-64.


(32) Morse, Elements of Geography (1795), 67. C. Johnson, Old-time Schools and Schoolbooks, 346. Johnson explains that in texts published during later years, geography authors referred to these successively as the Stony Mountains and then the Rocky Mountains.

(33) Samuel G. Goodrich, Malte-brun (1832), 282.

(34) "Waterton, the Naturalist," in The Youth's Companion, 65 (1892). The author goes on to explain that the rider was Charles Waterton, a well known English naturalist, and follow this opening with a biographical sketch.


and in the *Franklin Gazette* (Philadelphia, August 7, 1819).


(44) For a discussion of the character of the Enlightenment, see Hankins, *Science and the Enlightenment*, 1-16.


(49) Morse, *Geography Made Easy*, 186.

(50) For example, see Elson, *Guardians of Tradition*; Nietz, *Old Textbooks*.

(51) J. A. Cummings, *An Introduction to Ancient and Modern Geography, on the plan of Goldsmith and Guy* (Boston: Cummings and Hilliard, 1817), 42.

(52) Daniel Adams, *Geography or, a Description of the World* (Boston: West and Blake, 1814), 113.

(53) Frederick Butler, *Elements of Geography and History*


(58) Mann, "Report for 1848," in ibid., 263.


(60) From the preface of John O'Neill's *A New and Easy System of Geography and Popular Astronomy* (Baltimore: G. Dobbie and Murphy, 1808).

(61) The primary sources used in this study include 26 geography textbooks housed in Special Collections at Cubberley Library, Stanford University.


(64) Ibid., 46.


Morse, *Geography Made Easy*, 1816.


A Documentary History of Education in the South Before 1860 V, ed. Edgar W. Knight, 278-316; Ibid. II, 77-78.

Quoted in ibid., 305.

Morse, *Elements of Geography* (1795), preface.

William C. Woodbridge and Emma Willard, *Modern School Geography* (Hartford: Belknap and Hamersley, 1846), 45; See also Daniel Adams, *Geography: or, a Description of the World*, 94.

Morse, Jedediah, *Elements of Geography* (1795), 22.


For a discussion of the debates raging in the
geological community during the 1830s, see Bowler, Evolution: The History of an Idea, 134-141. David Lindberg and Ronald L. Numbers have written a provocative monograph that seeks to debunk the notion that nineteenth century geologists and theologians were on opposite sides of the fence on such issues as the Noachian flood, the Genesis account, and Darwin's theory of natural selection. See Lindberg and Numbers, "Beyond War and Peace: A Reappraisal of the Encounter between Christianity and Science," in Church History, 55 (September 1986): 338-354.

(82) Samuel G. Goodrich, A System of School Geography, Chiefly Derived from Malte-brun (Hartford: F.J. Huntington, 1832), 282; See also O'Neill, A New and Easy System of Geography, 490. In accounting for geological strata, most school book authors, like some contemporary geologists, made reference to the Deluge in the Old Testament. For example, see J.E. Worcester's Elements of Geography, 254.

(83) Elson, Guardians of Tradition, 16.

(84) Jedidiah Morse, Geography Made Easy (Boston: J.T. Buckingham, 1806), 74; C. Johnson, Old-time Schools and School-books, 322. According to Johnson, Morse included this information in his 1800 edition as well.


(87) Roswell Smith, Smith's Geography on the Productive System (1845), 11.

(88) The most extreme examples in the sample examined for this study are those by Dwight, Olney, and Peter Parley, a.k.a. Samuel G. Goodrich.

(89) The following texts are those written in the cathetical format: Dwight, A Short but Comprehensive System of the Geography of Our World; by Way of Question and Answer (1813); Goodrich, Peter Parley's Method of Telling About Geography to Children (1838); S. Augustus Mitchell, A System of Modern Geography (Philadelphia: E. H. Butler & Co. 1860); Jesse Olney, A Practical System of Modern Geography (1833); Roswell Smith, Smith's Geography on the Productive System (1845).


(92) The biographical information about Woodbridge was provided by an anonymous author described as "a veteran in female education" in the *American Annals of Education and Instruction*, 1 (September 1830): 421-2.


(94) Quoted in Nietz, *Old Textbooks*, 223.


(97) In the prefaces to the texts they coauthored, Woodbridge and Willard claim to have developed the inductive method independently. See *Rudiments of Geography* (1830), *A System of Universal Geography* (1829), and *Modern School Geography* (1846). Both Woodbridge and Willard began teaching before 1808, the date at which Pestalozzi's ideas were first brought to America by William Maclure, the Scottist geologist. See Will S. Monroe, *History of the Pestalozzian Movement in the United States* (Syracuse, New York: C. W. Bardeen, 1907). Maclure himself claimed only to have learned of Pestalozzi's system in 1805 (see Maclure's letter to Marie D. Frotegeot in Arthur E. Bestor Jr., ed. *Education and Reform at New Harmony: Correspondence of William Maclure and Marie Duclos Pretageot 1820-1833* (Indianapolis: Indiana Historical Society, 1948), 301. The quote is from Samuel S. Goodrich, *Peter Parley's Method of Telling About Geography to Children* (Philadelphia: Thomas, Cowperthwait and Co., 1838), 1.


Chapter 2

Science for Ladies, Classics for Gentlemen

Introduction

In 1864, the British government established the Taunton Commission to conduct an inquiry into the education of middle-class boys. Concerned about the status of the arts and sciences in the schools, the Commission directed its appointed inspectors to pay particular attention to scientific subjects. Almost as an afterthought, the Commission decided to investigate the conditions in girls' schools as well. From 1864 to 1868, inspectors traveled throughout Great Britain, observing classes, interviewing headmasters and headmistresses, and examining students in private, proprietary, and endowed schools.¹

To their surprise, members of the Taunton Commission discovered that while the sciences maintained at best a marginal toehold in boys' schools, they were quite popular in girls' schools. While a boy's education centered around Latin and Greek, a girl's education included ample doses of botany, chemistry, natural philosophy, natural history, and physiology.²

Did comparable conditions exist in the United States? Based on data compiled from newspaper advertisements, published accounts of school examinations, and state superintendents' reports, this study aims to demonstrate that similar conditions indeed existed in America during the
first half of the nineteenth century. The data support the thesis that by 1840, the subjects of natural philosophy, chemistry, and astronomy had become more prevalent in American schools for middle- and upper-class girls than in comparable institutions for boys.\[^3\]

The inclusion of scientific subjects in the courses of study of American female seminaries and academies in the early nineteenth century has been noted by historians of women's education. When Thomas Woody published his classic history of women's education in 1929, he included an appendix listing the subjects offered in 162 female seminaries between 1742 and 1871. Natural philosophy, astronomy, chemistry, and botany were among the ten subjects most frequently listed by the seminaries in Woody's sample. More recent studies have described in some detail the many opportunities afforded girls to study scientific subjects in their academies and seminaries. Until now, however, there has been insufficient data upon which to base a comparison of the relative emphasis placed on the sciences in boys' and girls' schools.\[^4\]

It has been a long-standing paradigm in histories of science education to date the rapid infusion of the sciences into the secondary school curriculum from the publication dates of such writers as Thomas Huxley and Herbert Spencer in the 1850s and 1860s.\[^5\] This study suggests that this paradigm has misled us in fundamental ways. While the writings of such men as Huxley and Spencer were undoubtedly
pivotal in efforts to increase the science curriculum, first at the college, and then at the secondary level, this increase represented a marked change for only half of the American student population. While the decades after the 1860s saw an increase in the sciences in male colleges, boys' academies, and co-educational secondary schools, the data revealed here indicate that the sciences had already long formed a visible part of the schooling of American girls.

* * *

During the last decades of the eighteenth century, American reformers developed several rationales for the education of females, often basing their arguments on women's social roles as mothers, wives, and teachers. The education of women was crucial to the welfare of the state because the primary duties of motherhood included "the education for time and eternity of the next generation of immortal beings." As a wife, a woman "must be able to comprehend [her husband's] plans; she must sympathize in his feelings, or else she cannot be his helpmate." The demand for teachers created a need that could be admirably filled by educated females, because "Women [were] the very best teachers in the primary education of children," being "less expensive teachers than men."

What was to be the proper course of study for girls? Because the mind of a woman, like that of a man, needed
discipline, some educators argued that girls should be instructed in the "solid" branches of science rather than in the merely "ornamental" branches of drawing, painting, and needlework. Although classical studies had traditionally played the role of training the mind, many educators argued that the sciences could serve the same function by training students to observe critically and think logically.

Advocates of science touted its social and physical benefits. According to the well-known female educator Almira Hart Lincoln Phelps, scientific study would result "in enlarging [women's] sphere of thought, rendering them more interesting companions to men of science, and better capable of instructing the young." Concerned about the physical strength of young American girls, educators and doctors alike recommended botany, a subject many contemporaries viewed as particularly suited to females because "its pursuits leading to exercise in the open are conducive to health and cheerfulness."

The rhetoric of natural theology, which portrayed the study of the natural world as spiritually and morally uplifting, made highly desirable the inclusion of the sciences into the curriculum. "The analysis of science and revealed religion," proclaimed John Ludlow in his 1834 address at the opening of Albany Female Academy, "will ultimately terminate in the same point...the invisible God." As did many members of the British and American scientific communities during this period, textbook authors
frequently invoked natural theology as they extolled the benefits of studying the sciences. In a statement fairly representative of the period, the popular textbook author J.L. Comstock assured his readers that chemistry was a suitable vehicle for moral instruction, because "this subject teaches, that nothing has been formed by the fortuitous concurrence of atoms, but that even the 'stocks and stones' bear the impress of creative agency and design."\textsuperscript{14}

Many contemporary justifications for girls and women studying science centered around their important social role as mothers and teachers of the sciences and useful arts, subjects deemed peculiarly suited to the development of the new republic. Many of the common school returns in the late 1830s mention the effectiveness of female teachers. The idea of having women teach was particularly appealing to financially strapped private school and public school boards, because the nation's population more than tripled from 1790 to 1830, and two or more female teachers could be hired for the price of one male.\textsuperscript{15}

While such influential Americans as Thomas Jefferson felt that the subjects of study most useful for American boys included both the classics and the sciences, relatively few reformers claimed that girls should study the classics.\textsuperscript{16} Traditionally, a classical education had been the prerogative of middle-class males, and it remained so past the mid-nineteenth century. Many educators looked to find
rigor in a program for girls, not to the classics at first, but to the sciences.17

The Rise of Academies, Seminaries, and Private Schools

Troy Female Seminary, which opened in 1821 under the leadership of Emma Willard, was an important center for the diffusion of new educational ideas in early nineteenth century. Earlier, the standard curricula in girls' secondary schools generally had included such basics as geography, English, writing, arithmetic, and plain needlework, along with several ornamental subjects offered on an elective basis. In contrast, the curriculum at Troy emphasized mathematics, science, modern languages, history, philosophy, geography, and literature. Such gifted speakers and prolific writers as Emma Willard and her sister Elmira Hart Phelps, Catharine Beecher, head of Hartford Seminary, Zilpah Grant, head of Ipswich Female Seminary, and Mary Lyon, head of Mount Holyoke Seminary, were highly influential in disseminating the new views of female education. Many of their graduates became teachers in distant states, bringing these ideas to different parts of the country.18

Newly-founded academies and seminaries advertised their courses of study in local newspapers in order to attract students. During the period from 1800 to 1845, such advertisements often provided a complete list of the subjects offered in schools, sometimes accompanied with the titles of the textbooks used in various courses. Catharine
and Mary Beecher's 1824 advertisement is representative in its degree of detail (see Plate 1).

Plate 1
1824 Newspaper Advertisement for Catharine and Mary Beecher's School in Connecticut
(Courtesy of Department of Special Collections, Stanford University Libraries)

Misses C. & M. BEECHER

WILL commence their summer term on the first Wednesday after Election, (May 12)
For those who may attend from out of town, a list of the books to be used in the school during the summer is subjoined. Murray's Grammar, Woodbridge's large and small Geography, Blair's Rhetoric, Mrs. B.'s Conversations on Philosophy and Chemistry, Goldsmith's Histories of Greece and Rome, Russell's Modern Europe, Adams' Arithmetic, Day's Algebra, Euclid's Elements of Geometry, Paley's Moral Philosophy, Pal. Natural Theology, Adams' Latin Grammar, Historiae Grecae, and Virgil. The arrangements of the school will be such, that it will be a great advantage to enter at the commencement of the terms. Terms. For tuition, $6. For drawing, $2. For music, $10, per quarter.

April 5.

April 5, 1824.

67

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Although advertisements are unreliable as a means of evaluating either the content or method of the actual instruction delivered in educational institutions, as marketing tools, these sources illuminate the degree to which educational institutions differentiated their curricula according to the gender of their desired clientele.

During the first half of the nineteenth century, the curriculum of academies and seminaries expanded enormously. Increasing criticism of the emphasis on ornamentals in girls' education, and a rising belief that girls were indeed endowed by nature with minds to be trained by discipline, led many schools to include such presumably solid subjects as natural philosophy, astronomy, chemistry, and (more rarely) botany during the 1820s and 1830s.20

In order to remain competitive in attracting students, schools advertised when they added new subjects to their courses of study, or when they added new teachers, textbooks, or scientific apparatus to their programs. A fairly typical example of the curriculum expansion in girls' schools can be seen in the growing number of subjects advertised by North Carolina Shocco Female Academy from 1818 to 1830 (see Table 1).
### Table 1

Expansion of the Curriculum of Shocco Female Academy, North Carolina, 1818-1830

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<th>1818</th>
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<td>Nat'l Phil</td>
<td>Chemistry</td>
<td>Botany</td>
<td>History</td>
<td>Music</td>
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The tuition rates in newspaper advertisements indicate that the sciences never attained the core status of such basic subjects as reading, writing, or arithmetic. Nevertheless, the sources examined for this study indicate that more girls' schools included scientific subjects in the basic course of studies, referred to as the English course, than the so-called ornamental subjects. For instance, in a sample of thirty-one girls' schools in North Carolina, 42 percent included the sciences under the basic tuition, while 58 percent charged extra. In contrast, the so-called...
ornamental subjects, comprising music, painting, drawing, embroidery, and so on were almost always offered on a supplemental basis and were sometimes taught by adjunct faculty. The additional tuition charged for the ornamental subjects was often as much, or even greater than the tuition for the entire English course, which often included the sciences. In 1831, a girl seeking to study the subjects of Drawing, Painting, and Music in the Wake Forest Female School had to pay twice the tuition of the English course:

The course of instruction will be that usually pursued, viz; Reading, Writing, Arithmetic, History, Natural Philosophy and Astronomy, Composition, Plain Needle Work and Embroidery, Drawing and Painting, and Music on the Piano. The prices of Tuition for the Session of five months, will be; for the ordinary branches of an English Education $10--Needle Work and Embroidery $5--Drawing and Painting, $5--Music on the Piano $15, payable always in advance.

**Science for Young Ladies**

Although some of the most prominent female seminaries included such traditionally male subjects as Latin and Greek in their courses of study, a minority of schools followed this pattern until later in the century, choosing instead to offer students an educational program deemed more suitable for females. During the second and third decades of the nineteenth century, an increasing percentage of institutions advertised a curriculum that included such subjects as astronomy, natural philosophy, chemistry, and, to a lesser extent, natural history. So prevalent was the addition of
science to a girl's course of studies in North Carolina in 1826, that the female department of Tarborough Academy described its program as being "as extensive as at other Female Seminaries, including Chemistry, Astronomy, Natural Philosophy, Rhetoric and History." The Academy's advertisement added that "such as desire it may be taught plain and ornamental Needle Work, Painting on Paper and Velvet, and Music.25 Similarly, the 1830 prospectus of Connecticut's New Haven Female Seminary claimed that its course of study embraced "all the scientific and ornamental branches necessary to complete the female education."26

Visitors from abroad were struck by the relatively rigorous education of American girls. De Toqueville contrasted the cloistered schooling of girls in France with the practice in America, where "unable and unwilling to keep a girl in perpetual and complete ignorance, [Americans] are in a hurry to give her precocious knowledge of everything."27 The Englishwoman Frances Trollope, who lived in the United States for several years during the late 1820s, recounted her experience at the annual public exhibition of a New England girls' school, where she "perceived, with some surprise, that the higher branches of science were among the studies of the pretty creatures I saw assembled there."28 In 1850, the Swedish writer Fredrika Bremer concluded that American girls advanced as far in their scientific studies
as did American boys:

...opportunity is afforded [girls] to advance as far as the young men in study and the sciences, which have hitherto been considered as too difficult for them, are as easy for them to acquire as that superficial knowledge and accomplishment to which hitherto their education has been restricted.29

In actuality, relatively few American girls had either the leisure or financial means to study the sciences. Some of the textbooks published during the antebellum period reveal the assumptions of contemporaries about the social status of females who engaged in scientific investigation. For example, Richard G. Parker's Juvenile Philosophy, a popular elementary text, conveys scientific principles through the medium of a mother's conversation with her daughter. The elite status of this pair is implied in their surroundings and apparatus. One illustration depicts the two of them in a well-appointed drawing room, using a gold coin to perform a science experiment (see Plate 2).30

While the study of the sciences was largely the prerogative of the middle and upper classes, it was not restricted to the children of Anglo-Saxon, Protestant families. Indications of the movement to bring science into girls' courses of study can be found in some Catholic schools and in several academies serving Native Americans.

Although Catholicism was a minority religion of relatively new immigrants, some of the academies run by various orders of the Catholic church adapted to the newer
you to understand. But I will try to make it easy for you to understand. There is a basin of water on the table. Take this gold coin and put it into the basin, and tell me where it goes to.

CHILD.—It has gone down to the bottom of the basin, mother.

MOTHER.—Now take the cork from that bottle, and put that into the basin.

CHILD.—I have done so, mother, but the cork remains on the top of the water.

MOTHER.—Take the cork in your hand, my dear,
American views of female education by offering scientific subjects to middle class girls. For example, in 1842 the Maryland Carmelite Sister's Academy advertised natural philosophy, botany, and astronomy in its course of study, along with such other subjects as sacred history.31

In frontier St. Louis, the Society of the Sacred Heart reserved most scientific subjects for the daughters of well-to-do families. In her discussion of the Society of the Sacred Heart schools in St. Louis, Nikola Baumgarten describes both the curriculum offered to indigent girls in the free school and that offered to girls in the order's more prestigious academy. In the free school, girls studied reading, writing, spelling, arithmetic, and religion. Advanced studies, offered in the 1830s for a small fee, included grammar, geography, and sewing. In contrast, girls in the academy studied natural philosophy, astronomy, chemistry, and geography along with the other usual branches of a presumably solid education. Baumgarten attributes the inclusion of scientific subjects in the Catholic curriculum to the influence of such female educators as Emma Willard and Catharine Beecher.32

Scientific subjects were also offered to the daughters of elites in the Cherokee Nation. Since 1839, wealthier mixed-blood Cherokees had sent their daughters to the Fayetteville Female Academy in Arkansas, where they were instructed in geography and ancient history, logic, natural philosophy, literature, astronomy, and other subjects.
conducive to elevating the "female character in the Nation."

Established in Tahlequah in 1843, another option for young Cherokee females was the Cherokee Female Seminary, where pupils were instructed in a curriculum that included the natural sciences.\textsuperscript{33}

In 1847, the Cherokee National Council enacted a law requiring the teachers of the Female Seminary to teach "all the branches of literature and science commonly taught in the academies of the United States." As a source of faculty for the Seminary, Cherokees looked to Mary Lyon's Mount Holyoke Female Seminary. According to the historian Devon A. Mihesuah, between 1839 and 1856, twenty-four Mount Holyoke alumnae taught among North American tribes.\textsuperscript{34}

Modeled on the curriculum at Mount Holyoke Female Seminary, the course of study at Cherokee Female Seminary was distinguished from that in the Nation's common schools by its emphasis on literature and the sciences. In 1852, students in Cherokee common schools studied a basic course of reading, spelling, geography, and arithmetic. During the same period, the daughters of wealthier Cherokee families were instructed in such additional subjects as botany, natural philosophy, and astronomy.\textsuperscript{35}

Facing educational restrictions more severe than those of any other ethnic group in the United States, African Americans had few opportunities to study the sciences. In spite of enormous obstacles, however, occasionally an individual free African American gained access to schooling.
generally reserved for elites. Such an individual was Charlotte Forten Grimke, who came of a free elite Philadelphia family. In the 1850s, she attended school with white students in Salem, Massachusetts. Her journal entries reveal that while a student at Higginson Grammar School, she studied geography, geology, natural philosophy, and entomology.36

Science for Girls, Classics for Boys

A variety of contemporary sources indicate that while the sciences maintained a marginal presence in boys' academies, they were highly visible in girls' schools. Newspaper advertisements published in both northern and southern states reveal that a larger percentage of female institutions advertised scientific subjects than did male institutions during the same period. As shown in Tables 2-4 below, natural philosophy, astronomy, and chemistry comprised the most commonly advertised sciences in both male and female institutions. Botany appeared in a majority of girls' schools only after 1840.

In comparing the results for northern and southern states, there appears to be little regional variation in the percentage of girls' schools advertising scientific subjects; the higher figures reported for Pennsylvania are attributable to the later time period (1830-1889) represented by the schools in Mulhern's sample. However, although evidence is sketchy, the newspapers examined for
Table 2

Percentage of North Carolina and Virginia Secondary Schools Advertising Various Sciences, 1800-1840

<table>
<thead>
<tr>
<th></th>
<th>Nat'l Philos.</th>
<th>Astron-omy</th>
<th>Chemistry</th>
<th>Botany</th>
<th>Mineral-ogy</th>
<th>Nat'l History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls' Schools</td>
<td>74%</td>
<td>47%</td>
<td>54%</td>
<td>35%</td>
<td>5%</td>
<td>13%</td>
</tr>
<tr>
<td>(n=78)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys' Schools</td>
<td>47%</td>
<td>22%</td>
<td>21%</td>
<td>2%</td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>(n=86)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Data compiled from newspaper advertisements for 61 Virginia schools published in the Richmond Enquirer (Virginia, 1835-38), and 103 schools included in North Carolina Schools and Academies 1790-1840, ed. Coon.

Table 3

Percentage of Secondary Schools in Selected Northern States Advertising Various Sciences, 1820-1842

<table>
<thead>
<tr>
<th></th>
<th>Nat'l Philos.</th>
<th>Astron-omy</th>
<th>Chemistry</th>
<th>Botany</th>
<th>Mineral-ogy</th>
<th>Nat'l History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls' Schools</td>
<td>63%</td>
<td>50%</td>
<td>58%</td>
<td>25%</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>(n=24)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys' Schools</td>
<td>53%</td>
<td>33%</td>
<td>53%</td>
<td>27%</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>(n=15)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Data compiled from newspaper advertisements for 39 schools published in American Mercury (Connecticut, 1820-29 [incomplete]); Columbian Centinel (Massachusetts, 1827-31); Baltimore Sun (Maryland, 1841-42); New York Evening Post (August 1, 1835-May 31, 1836); The Globe (Washington D.C., 1831); Daily National Intelligencer (Washington D.C., 1825).
Table 4
Percentage of Pennsylvania Secondary Schools Offering Various Sciences, 1830-1889

<table>
<thead>
<tr>
<th></th>
<th>Nat'l History</th>
<th>Astron-omy</th>
<th>Chemistry</th>
<th>Botany</th>
<th>Mineral-ogy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls' Schools (n=90)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nat'l Philos.</td>
<td>88%</td>
<td>67%</td>
<td>72%</td>
<td>77%</td>
<td>33%</td>
</tr>
<tr>
<td>Boys' &amp; Coed Schools (n=116)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nat'l Philos.</td>
<td>54%</td>
<td>47%</td>
<td>56%</td>
<td>33%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Source: Data compiled from tables in James Mulhern, A History of Secondary Education in Pennsylvania, 328-29; 428-29.37

This study indicates that a larger percentage of boys' schools in northern states advertised the sciences than did their southern counterparts, a trend which may have developed in response to the growing industrialization of the North.

While a girl's education commonly included doses of scientific subjects, a boy's education more often centered around Latin and Greek, particularly in the South. For example, in Virginia and North Carolina, Latin was the most frequently advertised subject in boys' academies and private schools from 1790 to 1840; 91 per cent of boys' schools advertised Latin, and 85 per cent advertised Greek. In contrast, only 18 per cent of girls' schools advertised Latin, and a very meager five per cent advertised Greek. In
the North, only a slightly larger percentage of boys' schools than girls' schools advertised Latin, although female institutions usually offered the subject on an elective basis only.\textsuperscript{38}

Table 5

Comparison of the Male and Female Courses of Study Advertised by Vine Hill Academy, North Carolina, 1837

<table>
<thead>
<tr>
<th>Male Department</th>
<th>Female Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spelling</td>
<td>Spelling</td>
</tr>
<tr>
<td>Reading</td>
<td>Reading</td>
</tr>
<tr>
<td>Writing</td>
<td>Writing</td>
</tr>
<tr>
<td>Grammar</td>
<td>Grammar</td>
</tr>
<tr>
<td>Geography</td>
<td>Geography</td>
</tr>
<tr>
<td>History</td>
<td>History</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>Arithmetic</td>
</tr>
<tr>
<td>Rhetoric</td>
<td>Rhetoric</td>
</tr>
<tr>
<td>Logic</td>
<td>Logic</td>
</tr>
<tr>
<td>French</td>
<td>French</td>
</tr>
<tr>
<td>Latin</td>
<td>----</td>
</tr>
<tr>
<td>Greek</td>
<td>----</td>
</tr>
<tr>
<td>Algebra</td>
<td>----</td>
</tr>
<tr>
<td>Geometry</td>
<td>----</td>
</tr>
<tr>
<td>Navigation</td>
<td>----</td>
</tr>
<tr>
<td>Surveying</td>
<td>----</td>
</tr>
<tr>
<td>Natural Philosophy</td>
<td>Chemistry</td>
</tr>
<tr>
<td>----</td>
<td>Cancer</td>
</tr>
<tr>
<td>----</td>
<td>Astronomy</td>
</tr>
<tr>
<td>----</td>
<td>Botany</td>
</tr>
<tr>
<td>----</td>
<td>Moral &amp; Intellectual Philosophy</td>
</tr>
<tr>
<td>----</td>
<td>Natural Theology</td>
</tr>
<tr>
<td>----</td>
<td>Elements of Criticism</td>
</tr>
<tr>
<td>----</td>
<td>Drawing &amp; Painting</td>
</tr>
</tbody>
</table>

Source: Data compiled from the Raleigh Star (May 17, 1837), in North Carolina Schools, ed. Coon, 176-177.

Another way to compare the curricula offered to the two sexes is to examine the courses of study in schools with both male and female departments. Of the 103 schools
represented in the North Carolina sample, seven placed advertisements describing curricula for the male and female departments of the same institution. Six of the seven institutions advertised a different science curriculum for their male and female departments. The curriculum of Vine Hill Academy exemplifies variations in the subjects available to middle class males and females; the classics, higher mathematics, navigation and surveying were offered to males, whereas natural philosophy, astronomy, chemistry, botany and several other subjects were offered to females (see Table 5 above).

In New York's Genesee Wesleyan Seminary, which offered the same number of scientific subjects to both sexes in separate departments, girls predominated in the science courses. Despite the fact that males comprised 62 percent of the student body in 1834, enrollment data reveal that a significantly larger percentage of females than males studied the sciences (see Table 6).

Table 6

<table>
<thead>
<tr>
<th></th>
<th>Total Enrollment</th>
<th>Natural Philos.</th>
<th>Astronomy</th>
<th>Chemistry</th>
<th>Botany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>144</td>
<td>85 (58%)</td>
<td>7 (5%)</td>
<td>33 (23%)</td>
<td>11 (8%)</td>
</tr>
<tr>
<td>Boys</td>
<td>232</td>
<td>64 (28%)</td>
<td>0 (0%)</td>
<td>20 (9%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

According to historian Nancy Beadie, "males, by contrast, dominated in Latin, algebra, Greek, Hebrew, bookkeeping, trigonometry, various branches of applied geometry (for surveying and navigation.)"  

School examinations provide another source of information about the relative importance of scientific subjects in the curriculum. Newspapers occasionally published accounts of the examinations of the larger and more prestigious local academies and seminaries, often including the names of examinees and the subjects on which they were examined. While institutions may have included scientific subjects in their advertised courses of study in order to appeal to a broad market of parents and guardians, the published reports of examinations indicate to a far greater degree the subjects that students actually studied.

Because the success or failure of its students reflected on the quality of instruction at each institution, it is unlikely that subjects taught incidentally were included in examinations. Public examinations were high stakes performances. They were conducted orally, often in the presence of a large audience of relatives, ministers, trustees, and visiting preceptors from other schools. In an era when few forms of public entertainment were available, the examinations in some cases assumed the form of a spectacle. When Mary Lyon was teaching at Ipswich Female Seminary with Zilpah Grant, "public examination carryalls from Andover rolled over to Ipswich to help swell the
audience." The examinations sometimes lasted for several days, no doubt creating an atmosphere of terror and excitement for students.

In their academies, boys were almost always examined on the classics and on such core subjects as geography, arithmetic, and grammar. For example, at North Carolina's Raleigh Academy in 1807, while the rest of his classmates endured questions on such topics as Horace, Virgil, Caesar, Selectae Veterii, Erasmus, Aesop's Fables, the Greek Testament, and Latin Grammar, Thomas Gales was the sole student examined on natural philosophy and astronomy, evidencing "by his ready and unembarrassed answers, his perfect acquaintance with them." It was not uncommon for a boys' academy to include natural philosophy or astronomy in its advertised course of study but to exclude these subjects from its examinations.

Published accounts of examinations in North Carolina reveal that a greater percentage of girls' schools included scientific subjects in their exams than did boys' schools of the same period (see Table 7 below). Although the majority of girls were examined on such core subjects as geography, reading, spelling, and grammar, and on such ornamentals as fancy needlework and painting, it was not uncommon also to find classes of girls examined in natural philosophy, astronomy, or chemistry. Female students generally impressed their examiners with their knowledge of various scientific subjects. For instance, in 1826, the
Table 7

Percentage of Selected North Carolina Schools Including Scientific Subjects in Their Examinations, 1800-1840

<table>
<thead>
<tr>
<th>Girls' Schools (n=9)</th>
<th>Boys' Schools (n=14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>78%</td>
<td>14%</td>
</tr>
</tbody>
</table>

Source: Data compiled from newspaper advertisements in North Carolina Schools and Academies, ed. Coon.

Examiners of Charlotte Female Academy noted with admiration that "the abstruse principles of Natural Philosophy and Astronomy were fully comprehended and understood by those who are yet but children."46

In New England, the examinations given in the common schools of Boston, Massachusetts under the leadership of Horace Mann reveal a similar situation. The Boston common schools of this period offered free instruction to the children of Boston's citizens. Each school was really two schools in one, a writing school and a grammar school. The master of the writing school taught the subjects of writing, arithmetic, algebra, geometry, and bookkeeping, and the master of the grammar school taught the subjects of grammar, reading, geography, history, and sometimes natural philosophy and astronomy.46

The School Committee of the City of Boston appointed a sub-Committee in 1845 to examine the highest, or first class in each of the nineteen grammar schools in Boston. Five schools catered exclusively to girls, five to boys, and the
remaining schools were coeducational. The students in the first classes were about to graduate, being on average 14 years old. Among the tests created for this purpose were those in natural philosophy and astronomy. The same examinations were administered to each of the schools in the city, and the tabulated results published in detail, question by question and school by school.

Thirteen of the nineteen common schools in Boston reportedly offered natural philosophy as an elective, and four offered astronomy on the same basis. Because taking the examinations in these subjects was optional, schools that did not provide instruction in astronomy or natural philosophy declined to submit scholars for questioning.

All five of the girls' schools produced scholars for the natural philosophy examination, and two of these schools, Franklin and Johnson, produced scholars for the astronomy examination as well. In contrast, only two boys' schools produced scholars for the natural philosophy examination, and no boys' school consented to be examined on astronomy (see table 8.)

Because students from both the top-ranked girls' and boys' schools took the examination in natural philosophy, it is possible to compare the relative performance of boys and girls. According to the examining committee, Bowdoin was the top-ranked girls' school, and Brimmer was the top-ranked boys' school. Although the scores overall were rather disappointing to the citizens of Boston, the girls' scores
## Table 8
Students in Boston Common Schools Examined in Natural Philosophy and Astronomy, 1845

<table>
<thead>
<tr>
<th>Girls' Schools</th>
<th>Enrollment</th>
<th>Number Examined in Nat. Philos.</th>
<th>Number Examined in Astronomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowdoin</td>
<td>508</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>Wells</td>
<td>307</td>
<td>27</td>
<td>0</td>
</tr>
<tr>
<td>Franklin</td>
<td>418</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Hancock</td>
<td>509</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Johnson</td>
<td>547</td>
<td>44</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2289</strong></td>
<td><strong>150</strong></td>
<td><strong>69</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Boys' Enrollment</th>
<th>Number Examined in Nat. Philos.</th>
<th>Number Examined in Astronomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brimmer</td>
<td>513</td>
<td>35</td>
</tr>
<tr>
<td>Eliot</td>
<td>456</td>
<td>0</td>
</tr>
<tr>
<td>Adams</td>
<td>418</td>
<td>0</td>
</tr>
<tr>
<td>Mayhew</td>
<td>368</td>
<td>19</td>
</tr>
<tr>
<td>New South</td>
<td>136</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1891</strong></td>
<td><strong>54</strong></td>
</tr>
</tbody>
</table>


were much higher than those of the boys. The girls from Bowdoin correctly answered 36 percent of the questions on the natural philosophy examination, whereas the boys from Brimmer correctly answered only 19 percent.51

The evidence provided by newspaper advertisements, tuition rates, and reports of school examinations reveals a distinctly greater emphasis on scientific subjects in schools for middle-class girls than in similar institutions for boys. At first offered to the children of elites in academies and seminaries, the sciences began to appear more
frequently in common schools in the late 1830s. A sampling of the school returns in Massachusetts reveals a substantial increase in the percentage of towns reporting the use of science textbooks in the common schools during a brief four-year period beginning in 1837 (see table 9).

Table 9

Massachusetts Towns Reporting Science Textbooks in Their Common Schools, 1837 and 1841

<table>
<thead>
<tr>
<th>Science Textbook</th>
<th>1837</th>
<th>1841</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural philosophy</td>
<td>17</td>
<td>73</td>
</tr>
<tr>
<td>Astronomy</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Chemistry</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Natural history</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Data compiled from a random sampling of thirty towns each in Abstract of the Massachusetts School Returns, 1837, and Abstract of the Massachusetts School Returns, 1840-41.

Social and Cultural Influences

In order to understand why the sciences became more prevalent in middle-class girls' schools than in comparable institutions for boys before the Civil War, it is important to consider some of the social and cultural context influencing these institutions in the early nineteenth century.

One explanation for the dominance of the traditional classical curriculum in boys' academies lies in the entrance requirements of local colleges. In 1810, the University of Pennsylvania required candidates to translate Caesar's Commentaries and Virgil, to translate English exercises into Latin, and to translate the Gospels from Greek. Thirty
years later, admission requirements of male colleges generally covered parts of Caesar, Virgil, Cicero, the *Anabasis* and the *Iliad*. Many college presidents were ministers serving under predominantly clerical boards of trustees. Trained in the classics themselves, such leaders valued a classical education as the best preparation for college. For students who were college bound, the years of study necessary to achieve mastery in the classics must have left little time for other studies. Nathaniel True, a student at Maine's North Yarmouth Academy during the 1820s, recalled his classical studies as being all-consuming:

I sat up one night a week during the term without retiring and studied every night until midnight. I averaged more than eighteen hours a day in getting my two Latin lessons each day for recitation.

A second reason for the durability of the classical curriculum was the social prestige of classical study in American nineteenth-century culture. Although the majority of academy students may not have gone on to college, the attainment of classical knowledge conferred a gentlemanly polish on boys who eventually planned to manage their fathers' plantations or pursue a career in business. In their interviews with British middle-class parents in the 1860s, inspectors for the Taunton Commission discovered that parents simply did not wish to experiment with the education of their sons. Instead, parents expressed the belief that "to learn the classics was a definite mark of an upper class
and clearly separated the education of their sons from that of a merely commercial school." Americans were undoubtedly equally anxious to maintain or elevate the social status of their children.

The schoolmasters in boys' academies constitute a third factor in the resistance of these institutions to offer scientific instruction. Having been trained in the classics themselves, many instructors were probably reluctant to add new subjects to the curriculum. Often, those who defended Latin as the ideal educational instrument for mental training had vested interests in maintaining the status quo, being either schoolmasters or professors of Latin in college classics departments.

A fourth influence on the curricula in male academies was the existing job market. Because there were relatively few profitable career opportunities for young men as physicists, astronomers, geologists, or botanists in the early nineteenth century, there was little incentive to promote these subjects in the academies on the basis of their vocational value. By the third decade of the century, the era of the great surveys was just beginning. In 1830, a writer noted that the science of geology was virtually unknown in the smaller communities of the United States:

A geologist in a retired town, engaged in his examination of rocks, is often surrounded by a collection of individuals, eyeing him with contempt; pity, or suspicion.
Even forty years later, the appearance of a scientist in a small town was a novelty. Although entrance to the medical profession required scientific study, those aspiring to become doctors traditionally studied the sciences in college after a rigorous classical training at the academy. A similar path, in which classical training preceded scientific study, lay ahead of those seeking to become professional scientists.

In fact, what might be termed vocational subjects were relatively scarce in academies before 1840. For example, while some forms of employment required knowledge of navigation, mensuration, or surveying, fewer than a third of academies in Pennsylvania and North Carolina provided instruction in these subjects before 1840. This state of affairs can be explained by the existence of competing institutions. Such institutions as mechanics' institutes and other evening schools offered vocational training to young men needing to work during the day. The following advertisement for an evening school in North Carolina is fairly representative:

The subscriber will open an Evening School...[where] will be taught Reading, Writing, English Grammar, Geography, Arithmetic, Trigonometry, Mensuration of Surfaces and Solids, Navigation and Surveying.

We can infer that many upper- and middle-class American parents considered the study of the sciences an unnecessary frill in the education of their sons. Marketing their
programs to this audience through local newspapers, male academies advertised the classics far more frequently than the sciences. It is likely that parents disdained the sciences because such subjects were not needed to gain entrance to college, had little value in imparting the gentlemanly polish of liberal culture, and afforded relatively few career opportunities. When he visited America in the 1850s, Swedish commentator Per Siljestrom noted with surprise that Americans appeared to hold the natural sciences in relatively low esteem.\textsuperscript{64}

Although parents may not have considered the sciences quite good enough for their sons, they viewed them as acceptable for their daughters. The most important factor in the rise of scientific subjects in girls' schools is the novelty of the institutions themselves. Unlike boys' academies, which were preceded by the Latin grammar schools, there was no precedent for the curriculum in female seminaries. As a result, educational reformers seeking to bring the sciences into secondary schools were far more likely to succeed in girls' schools.

College entrance requirements, so influential in the male academies, held little sway over educational institutions for girls. Because colleges were generally not open to women before 1850, girls' schools were free of the burden of preparing students for entrance requirements in the classics.\textsuperscript{65} In addition, the study of the classics was traditionally the prerogative of males. In 1803, one writer
who supported the education of girls nevertheless cautioned against allowing them to study the classics, advising parents to "Let your girls to in hand with your boys, as far as reading, writing, and accounts; there draw a line, for girls have nothing to do with Latin and Greek."

The influence of trends from Europe undoubtedly played a part in the development of women's scientific interests in the United States. The eighteenth century witnessed an increase in the production of popular science in both Great Britain and France, and the numbers of science books written for a female audience gradually increased. These publications were primarily elementary textbooks for women and children, in which concepts of natural philosophy, chemistry, or natural history were conveyed through the medium of female characters, a format that effectively emphasized the appropriateness of women's scientific interests. Since the seventeenth century, there had been a steady flow of ideas from Great Britain and Europe to North America, and the same sources of transmission increased in the eighteenth century. Newspapers, books, pamphlets, and periodicals reprinted European and British articles and stories. In addition, personal contact by travel and correspondence guaranteed an exchange of ideas between countries. Soon, Americans published their own popular science books for women, and their texts quickly appeared on bookstore shelves next to European imports.

The almost complete lack of public opposition to the
study of science in girls' schools can be attributed to the tacit acceptance of this movement among many American scientists. For America's fledgling scientific community, there were benefits to be gained by encouraging girls and women to study the sciences. First, as popularizers of science, women helped to create a supportive public. In an era when few public funds were available for scientific enterprises, the popularization of science ensured a public receptive to the necessary financing of experiments, surveys, and expeditions. Second, as consumers of popular science, women's numbers swelled the audiences at Lyceum lectures, helping to pay the salaries of male scientists who traveled the lecture circuit. Also, such scientists as Benjamin Silliman, Denison Olmsted, Asa Gray, and others wrote science textbooks and developed scientific apparatus for the use of academies and seminaries, and the royalties from the sales of these texts in girls' schools must have produced handsome profits. Third, as collectors of mineral and botanical specimens, women amateurs served as unpaid assistants aiding the research efforts of professional male scientists in herbaria, museums, and colleges.

The social and cultural influences briefly outlined here helped to create an educational climate in which scientific subjects easily gained entry into the curricula of educational institutions for middle- and upper-class girls. While science was initially included in the courses of study of academies and seminaries, by the mid-nineteenth
century its presence was also beginning to be felt in common schools.

Ironically, the same elites who studied scientific subjects in seminaries and academies helped to dismantle science's privileged status by introducing it into common schools. The graduates of female seminaries often became schoolteachers. Having studied some natural philosophy, astronomy, or chemistry themselves, convinced of the utility and moral worth of such subjects, and supported in their purpose by like-minded contemporaries who advocated science in common schools, seminary graduates undoubtedly felt it only natural to introduce science to the older students in their classrooms.68

Conclusions

The central conclusion of this study is that increasingly towards the middle decades of the nineteenth century, a young woman's schooling included the study of the sciences. The reported courses of study of early girls' schools, seminaries, and academies evidences a greater emphasis on scientific subjects than the curricula of similar, contemporary institutions for boys.

Historians of science have frequently noted the rapid entry of women into scientific fields in the United States in the latter half of the nineteenth century. Heretofore, explanations of this phenomenon have centered either on the extra-curricular scientific literature increasingly aimed at a female audience during the late eighteenth and early
nineteenth centuries, or on the opening of colleges and universities to women during the latter decades of the nineteenth century. The research in this study reports a consistent body of evidence to support the conclusion that a scientific curriculum was widely implemented in schools for American girls from the first decades of the nineteenth century. The science education of American girls in the antebellum period thus constitutes a likely and hitherto overlooked factor in the rise of science as a female interest after the Civil War.

Notes

(1) Patricia Phillips, The Scientific Lady: A Social History of Women's Scientific Interests, 1520-1918 (London: Weidenfeld and Nicolson, 1990), 236. According to Phillips, members of the middle classes were defined as those occupying houses assessed at an annual value of twenty pounds or more. There were estimated to be between 974,000 children between the ages of five and twenty in this social class in approximately 10,000 educational institutions, most of which catered solely to boys.

(2) Schools Inquiry Commission, General Reports of the Assistant Commissioners, Southern Counties, VII (1867-68), 71; 206-7.

(3) The term "middle class" is used loosely here to denote those members of society able to afford the tuition rates of private secondary schools during the early nineteenth century.

(5) This view is promoted most recently in George DeBoer, *A History of Ideas in Science Education: Implications for Practice* (New York: Teachers College Press, 1991).


(10) Elizabeth Keeney, *The Botanizers* (Chapel Hill: University of North Carolina Press, 1992), 58ff. According to Keeney, Amos Eaton and Almira Hart Lincoln Phelps, sister of Emma Willard, were highly influential in promoting this view of the sciences among educators. For an example of similar views in a southern state, see "A Syllabus of a Course of Vacation Reading is Provided for the Students at South Carolina Female Collegiate Institute," in *A Documentary History of Education in the South*, V, ed. Knight, 412-413.


(15) David L. Madsen, *Early National Education, 1776-1830* (New York: John Wiley & Sons, 1974), 4. The difference in salary paid to male and female teachers was obtained from a
random sampling of school returns from thirty towns listed in *Abstract of the Massachusetts School Returns for 1837* (Boston: Dutton & Wentworth, 1839).


(17) Woody, *A History of Women's Education*, I, 413. Woody noted that Latin was offered in the more prestigious female seminaries after 1810. His sample of 162 school catalogs reveals that more than 50% of the schools listed Latin between 1810 and 1870, and approximately 25% listed Greek grammar (563-65). However, Woody's sample should be interpreted with caution, since only the larger and wealthier schools would have published catalogs during this period.


(19) "Misses C & M Beecher," in *American Mercury* (Hartford, Connecticut, April 20, 1824.)


(21) The samples of newspaper advertisements used in this study were selected on the basis of the specificity of their content. In many cases, it was not possible to tell from the advertisement whether the school served males or females, or both. Nor, in all cases, was the entire course of study provided. Some advertisers claimed to offer "the usual branches of education" in their schools, and such advertisements were too vague to be included in the samples. The samples included here are drawn from advertisements that clearly specified the gender served in the school and provided a detailed course of study.

(22) It is a fairly common misconception among historians of
education that the so-called ornamental subjects were a staple in the schooling of early nineteenth-century American girls. This interpretation of the place of ornamentals in female education has been preserved for decades in Thomas Woody's 1929 study of female education, in which Woody claimed that "the [female] seminary continued to offer the friperies of filigree, painting, music, and drawing in far greater profusion" from the time of Emma Willard and Catherine Beecher. See Woody, A History of Women's Education in the United States, I, 415.


(24) Historian Christie Farnham argues that Latin appears more frequently in southern girls' schools than in northern institutions. See Farnham, The Education of the Southern Belle, 28-32. However, the sources examined for this study do not support Farnham's thesis. Newspaper advertisements published in North Carolina and Virginia reveal that relatively few girls' schools in these two southern states offered Latin. During the decade from 1810 to 1830, only 7 (19 percent) of a sample of 36 North Carolina girls' schools included Latin in their advertised courses of study. Similarly, only 4 (13 percent) of a sample of 31 Virginia girls' schools mentioned Latin in advertisements published from 1835 to 1838. In contrast, 10 (42 percent) out of a sample of 24 girls' schools in Connecticut, Massachusetts, New York, and Maryland advertised Latin from 1820 to 1842. See discussion in Kim Tolley, "The Science Education of American Girls, 1784-1932" (Ed.D. dissertation, University of California at Berkeley, 1996), Chapter Eight.


(26) Quoted in Vera M. Butler, Education as Revealed by New England Newspapers Prior to 1850 (Ph.D. dissertation, Temple University, 1935), 188.


(28) Frances Trollope, Domestic Manners of the Americans (New York: Alfred A. Knopf 1949 [1832]), 82. See also pages 340ff, where Trollope includes the prospectus of a New York boarding school, presumably interesting to her readers because it contained large amounts of scientific, mathematical, and classical subjects.


(30) Richard G. Parker, Juvenile Philosophy: or, Philosophy
(31) See "Carmelite Sisters' Academy" in the Maryland Baltimore Sun (August 12, 1842).


(33) Devon A. Mihesuah, Cultivating the Rosebuds: The Education of Women at the Cherokee Female Seminary, 1851-1909 (Urbana: University of Illinois Press, 1993), 21. According to the author, there were two Cherokee Female Seminaries. The earlier institution, established in 1843, was shortlived. The second Cherokee Female Seminary, which is the subject of Mihesuah's book, was established in 1851.

(34) Ibid., 27.

(35) Ibid.

(36) The Journals of Charlotte Forten Grimke, ed. Brenda Stevenson (New York: Oxford University Press, 1988), 1-31; 82; 63; 89; 105; 107-108; 122. The quote is from her entry of May 28, 1854.

(37) Mulhurn's data is based on an analysis of school catalogs.

(38) This conclusion is based on an analysis of the newspaper advertisements mentioned in the above tables. Out of a sample of 24 girls' schools in New England states from 1820 to 1842, 42 percent advertised Latin, usually on an elective basis, in contrast to 47 percent of a sample of 15 boys' schools.

(39) New Bern Academy in Craven County, Fayetteville Academy in Cumberland County, Tarborough Academy in Edgecombe County, Greensborough Academy in Guilford County, Vine Hill Academy in Halifax County, Salisbury Academy in Rowan County, and Raleigh Academy in Wake County.

(40) Beadie, "Emma Willard's Idea Put to the Test," 560n.

(41) Quoted in Marr, Old New-England Academies, 247.

(42) Depending on the school's charter, examinations might be held at the end of each term or more frequently. At Salisbury Academy in North Carolina, both private and public examinations were held. Each year was divided into two sessions, each session consisting of two quarters. At the end of each quarter, a committee of the Trustees was appointed to conduct the quarterly examination. The committee took the last two days of the quarter to privately...
examine the classes on their various studies. Twice a year, a public examination took place, and the Trustees' report of the public examination was published in the papers. See Western Carolinian (September 19, 1820) in North Carolina Schools, ed. Coon, 360.

(43) Ibid., 399.

(44) This was a common practice of the Classical School in Charlottesville, Virginia, from 1835-1836. See the issue of The Richmond Enquirer for Nov. 10, 1835, which advertises its course of study, and the issue for Dec. 29, 1835, which reports its examinations.

(45) The Catawba Journal (December 5, 1826), in North Carolina Schools, ed. Coon, 235-36; see also The Raleigh Star (January 10, 1812) in ibid., 601. The examiners report discusses the students' extensive knowledge of Astronomy in Mordecai's Female Academy in Warrenton, North Carolina.

(46) "Boston Grammar and Writing Schools," in The Common School Journal 7 (Oct. 15, 1845): 311-17. Lengthy extracts from the report of the Boston School Committee were published in numbers 19-23 of the Journal in 1845; Otis W. Caldwell and Stuart A. Courtis, Then and Now in Education: 1845-1923 (Yonkers-on-Hudson: World Book Co. 1925), 11; 14. Although the writing and grammar schools were ungraded in Boston, older children were generally divided from younger children in four recitation groups called classes, corresponding somewhat to present-day grades. Students could not be admitted from the primary to the grammar and writing schools until they were seven years old, at which point they could enter the fourth class.

(47) According to the school committee report, one of the nine coeducational schools was set apart "for colored children." See Caldwell and Courtis, Then and Now, 11.

(48) Caldwell and Courtis, Then and Now in Education. It is possible to distinguish girls' schools from boys' schools from information given in extracts of the Boston School Committee Report (222-26). Copies of the original tests are reproduced both in Caldwell and Courtis's text and in The Common School Journal 7 (Dec. 1, 1845): 361-3.

(49) Caldwell and Courtis, Then and Now in Education, 168-169. Although the city of Boston offered scientific subjects on an elective basis in its common schools, the subject still retained something of its elite character. Apparently neither astronomy or natural philosophy were offered in the Smith school, an institution catering to African American children, because Smith declined to produce scholars for examination on either subject (see 342-344).
Ironically, although the examiners ranked Brimmer as the highest quality boys' school, its scholars were consistently outranked by other schools on the examinations in all subjects. The examiners, perhaps unable to see beyond the social status of Brimmer's students, nevertheless held unfailingly to a belief in the intelligence of the school's scholars: "The boys of the first class have...a general intelligence, which was perfectly obvious to the committee, but of which no record can appear in our tables" (184).

In fact, the girls' schools Bowdoin and Wells ranked within the top three schools on each of the remaining examinations as well, a phenomenon that must be interpreted with caution. Generally, girls stayed in school longer than boys. In Boston, boys were required to leave school at the end of the term after their fourteenth birthday, while girls could remain until the end of the term after their sixteenth birthday. The average age of the girls examined at Bowdoin was fourteen years, eight months, while the average age of the boys at Brimmer was thirteen years. Of course, age alone does not account for all the differences in scores. On the history examination, for example, boys from Adams school, whose average age was only twelve years and eleven months, outscored the girls from Wells, whose average age was thirteen years and three months (see 14; 330).

As late as 1864, the State Superintendent of Pennsylvania reported that "It is not probable that more than one-eighth of the students in the academies and seminaries pass on through a college course." Quoted in Rev. J. Fraser, Report on the Common School System of the United States and of the Provinces of Upper and Lower Canada (1867) mf 73.216-220, 106.

Quoted in Phillips, The Scientific Lady, 240.


(60) "Lucy Millington," unpublished manuscript by Liberty Hyde Bailey, file 1, box 8, Liberty Hyde Bailey Papers, Carl Kroch Library, Cornell University. Bailey, who grew up in South Haven, Michigan, wrote that he had seen only one botanist, a visiting lecturer in the town lyceum, before meeting Lucy Millington in 1876.

(61) Data compiled from Mulhern, *A History of Secondary Education in Pennsylvania*, 328: Mulhern's sample of 47 academies (1750 to 1829) reveals that 9 percent offered mensuration, 19 percent surveying, and 13 percent navigation; Data compiled from North Carolina Schools and Academies, ed. Coon: the advertisements of 56 academies from the period 1794 to 1840 reveal that 9 percent offered mensuration, 29 percent surveying, and 13 percent navigation.


(64) Per Siljestrom, *The Educational Institutions of the United States, Their Character and Organization* (London, 1853), 393.


(68) Writing in 1850, Susan Fenimore Cooper noted the introduction of scientific subjects into the curriculum of common schools in her community. See Cooper, *Rural Hours* (New York: George P. Putnam, 1850), 361; 366. Cooper cautioned that the introduction of the sciences into the curriculum came at the cost of a neglect of religious and moral instruction.

Introduction

In 1837, Virginia's Bedford Female Academy published a blistering indictment of the science education offered in rival institutions. According to Bedford's newspaper advertisement, the science commonly taught in female seminaries was a "pretended science taught only in name," a subject incapable of strengthening or adorning the female mind. Bedford also claimed that scientific study misled young women from their true vocation in the home:

Women are not destined to be Navigators, nor Opticians, nor Almanac-makers, nor Practical Mechanics, nor Miners, nor Engineers, nor Doctors of Medicine...[they] should understand...much more of Cookery than of Chemistry.1

The claims made by Bedford Academy raise two interesting questions about the science education of girls in the early nineteenth century. First, were girls indeed taught science "only in name," a science best characterized as rudimentary? Second, to what extent did the science in girls' schools include topics related to such traditionally male vocations as navigation, mining, mechanics, or engineering?

To date, no published study has undertaken a comparative analysis of the science studied in nineteenth-century girls' schools. As a result, historians have either
speculated, with understandable caution, that such study may have been quite elementary, or have boldly claimed, on the basis of the subject listings in girls' courses of study, that the sciences studied in female institutions were comparable to those offered in male institutions. Since the publication of Margaret Rossiter's study, *Women Scientists in America*, a number of scholars working in different fields have contributed to our understanding of girls' scientific interests in the nineteenth century. But as yet, an important question remains unanswered: How did the content and level of difficulty of the sciences offered to girls compare with those offered to boys?

One means of evaluating the science content offered the two sexes is to compare the textbooks used by each in their respective educational institutions. As a means of assessing actual classroom instruction, of course, this method is quite limited. For a number of imaginable reasons, the science girls learned in their schoolrooms may in fact have borne little resemblance to the content of their schoolbooks. In some cases, well-trained instructors may have set aside the texts altogether, preferring to teach by demonstration and discussion, while their less-prepared colleagues may have omitted entire sections of the texts in order to avoid potentially difficult or unfamiliar material. On the other hand, the students themselves may have been idly daydreaming, or preoccupied with
extracurricular matters during their science lessons, and thus retained little of the textbook content at the end of the course. Nevertheless, because most contemporary accounts of nineteenth-century schooling indicate that instruction and examination was based largely on recitation from texts, these sources bring us as close as we are likely to get to assessing the scientific content imparted in nineteenth-century classrooms.3

In spite of the limitations mentioned above, using textbooks as a source can illuminate two issues that are central to the study of gender and science. Because mathematics is foundational to the advanced study of the sciences, some scholars today argue that girls avoid scientific subjects because of their mathematical complexity. An examination of the textbooks used in nineteenth-century girls' schools can yield information about the level of mathematics included in the sciences then available to females. Textbooks can also reveal the extent to which precollege science content was differentiated by gender. Some late-eighteenth and nineteenth-century advocates of women's education argued that rather than learn so-called pure science, girls should attend to a domestic science focused on the activities of hearth and home. The degree to which their rhetoric was successfully implemented in practice can be illuminated by examining science textbooks written specifically for a female audience.

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In order to shed light on these and other issues, the following chapter compares the content and level of difficulty of natural philosophy, astronomy, and chemistry offered to boys and girls in their separate secondary schools before 1850. Because natural history and such related subjects as botany and geology occurred less frequently in the curricula during this period, they are considered in a later chapter.

Content

What kind of scientific content did nineteenth-century Americans offer their daughters? Since the mid-eighteenth century, colonial and later American bookstores had carried self-help texts aimed to instruct females on everything from "the choice of a Husband," to gardening, baking, and preserving foods.4 Seeking to institutionalize a distinctively female science curriculum, from an early period such educational reformers as Benjamin Rush, Catharine Beecher, Almira Hart Lincoln Phelps and others had advocated a curriculum for girls centered on the applications of science to the tasks of the household.5 Contemporaries used the term "domestic science" to indicate the specific application of scientific principles to domestic activities. Thus it was distinguished from the term "domestic arts," which denoted the activities of the household.

Professor of Chemistry at the University of Pennsylvania, Benjamin Rush had suggested a curriculum for
girls that included a "general acquaintance with the first principles of chemistry, and natural philosophy, particularly with such parts of them as are applicable to domestic and culinary purposes." As early as 1787, Rush actually taught such a chemistry course at the Young Ladies' Academy in Philadelphia. In this twelve-lecture course, Rush devoted the first seven lectures to general chemistry and the last five to the applications of chemistry to cooking and housekeeping, speaking on such topics as "the means of preserving female beauty," "the means of preparing vegetables for food," and "of rendering a house clean and wholesome."6

Given the prominence of those individuals who advanced the rhetoric of domestic science, it is not surprising that some historians have taken the rhetoric at face value, assuming that domestic science entered the curriculum of girls' schools through the work of such educators as Emma Willard and Catharine Beecher. However, an examination of the textbooks known to have been used in girls schools reveals that this was far from being the case.7

The first, certainly the most widely-used science text appearing in girls' schools from 1810 to 1830 focused on pure, rather than domestic science. This was Jane Marcet's Conversations on Chemistry, intended more especially for the Female Sex. Marcet's text appeared in England in 1805, achieving enormous popularity. The first American edition
appeared in 1806, and a sixteenth edition appeared in 1853. She wrote other **Conversations**: on vegetable physiology, on natural philosophy, and on political economy. According to Deborah Jean Warner, Marcet's **Conversations on Natural Philosophy** went through three dozen American printings before the Civil War, and her **Conversations on Vegetable Physiology** achieved a similar success. In her texts, Marcet wrote about the principles of science rather than its applications to the activities of the household.

Although Marcet was not the first to write science books specifically for a female audience, in the opinion of many of her contemporaries, she stood head and shoulders above the rest. In her **Biographical Sketches**, the well-known author Harriet Martineau wrote, "Mrs. Barbauld's Early Lessons were good; Miss Edgeworth's were better, but Mrs. Marcet's are transcendent as far as they go." The British scientist Michael Faraday was said to have taken up chemistry because of reading Mrs. Marcet's books as a youth.

The topics covered in Marcet's books were similar to those presented in elementary textbooks written primarily for a male audience. For instance, **Conversations on Natural Philosophy** included chapters on the properties of matter, mechanics, hydrostatics, hydraulics, pneumatics, acoustics, and optics. **Conversations on Chemistry** included chapters on light, heat, metals, alkalies, compound bodies, and muriatic and oxygenated muriatic acids. Although **Conversations on**
Chemistry also contained several chapters on vegetables and animals, these dealt with such topics as the various processes of fermentation, plant structure, animal physiology, and so on.11

Marcet's books were not unique in their coverage of scientific topics, for the lack of attention to so-called domestic science characterized almost every American science textbook used in girls' secondary schools before mid-century. Only two textbooks in the sample used for this study come close to what might be called domestic science.

The first is Almira Hart Lincoln Phelps's Chemistry for Beginners, first published in 1834. Herself an advocate of domestic science, Phelps occasionally inserted examples of the practical applications of chemistry into her text. For example, she included advice on how to make ice-cream, discussed the use of charcoal as an antiseptic, the uses of muriatic acid, and the effects of gypsum as a fertilizer.12 Nevertheless, even Phelps recognized the limited extent of her efforts to apply chemistry to women's sphere. Taken as a whole, the content of her book is similar to that of many other elementary texts used in male and female academies, with the notable exception that the illustrations depict girls performing various experiments, as shown in the example provided by Plate 3. In her introduction, Phelps acknowledged the scarcity of domestic science in her text.
505. A small piece of iodine (which may be obtained at a druggist's shop) put into a vial, will be sufficient to show many interesting properties of this substance. On holding it near the flame of a lamp, the solid will disappear and the vial be filled with a purple vapour. As soon as the vial is removed from the lamp, the iodine is again seen in the form of a solid lump, of a gray colour and without appearing to have undergone any change in its nature.

and advised female readers to attend to chemical principles in general:

As chemists are not housekeepers, nor housekeepers chemists, there has been little opportunity for the study of domestic economy in its relation to chemistry.13

The second is Richard G. Parker's Juvenile Philosophy: or Philosophy in Familiar Conversations (1850).14 Intended for the youngest readers in common schools, Parker wrote his
text as a series of conversations between a mother and her daughter about rain, color, vision, the eye, light, fire, heat and wind. It is domestic not in its content, but in its context; set within the environs of the kitchen and farmyard, the mother demonstrates the principles of science to her daughter.

Newspaper advertisements provide additional evidence that girls' schools preferred to purchase equipment more useful in demonstrating the principles of electricity than those of cookery. According to historian Deborah Jean Warner, aside from buildings and furnishings, scientific apparatus often represented the largest single investment made by a girls' school; as a result, the possession of apparatus was often treated as a prime attraction. In New York City, Rutgers Female Institute stated that few colleges could "boast of greater facilities for instruction."15 Schools equipped with the latest apparatus were quick to advertise the fact as a means of attracting potential students. For example, in 1837 F. G. Smith's girls' boarding school in Lynchburg, boasted of its extensive equipment:

The apparatus is very extensive, and contains all the leading and important instruments in the circle of Physical Sciences...A full Chemical apparatus, one of the largest electrical machines, with batteries, etc., models of all the varieties of Pumps, a superior Air Pump and Pneumatic apparatus, a series of working models illustrating the history of the steam engine, a large Solar Microscope...a splendid four-foot Gregorian telescope.16
Nor did scientific apparatus sit idly in the closets of girls' schools; girls used it to conduct demonstrations and experiments. For example, in 1815, the Raleigh Register reported that in the female department of Raleigh Academy, "The experiments made by the students in Chemistry did honor to Miss Nye (the female preceptress)." According to a 1823 advertisement in Andrews and Jones' North Carolina Female Academy, "the truths of Natural Philosophy, Chymistry and Astronomy, are experimentally illustrated." Three years later, North Carolina's Oxford Female Seminary went even further in declaring that every lecture in "Chymistry, Natural Philosophy, Astronomy and Mineralogy will be...illustrated by appropriate experiments." Institutions enrolling both sexes advertised the use of experimental lectures in both male and female departments. For example, in an 1827 advertisement, Groton Academy of Massachusetts claimed to offer experimental lectures in natural philosophy and chemistry in both its male and female departments.17

In order to understand the lack of attention to domestic science in school lectures and experiments and in the texts of Marcet and other schoolbook authors, it is necessary to consider the social and cultural context of the period. Marcet, like other writers of science textbooks, derived her information from the public lectures and treatises of well-known scientists, men who geared their presentations to a primarily male audience. As a result,
textbook writers seeking to develop a domestic science curriculum had no authoritative model to follow. Benjamin Rush, the only practicing scientist known to have developed such a curriculum, produced only a brief syllabus on which he based his lectures. Additionally, Rush taught his domestic science course only once, and his syllabus was never reprinted in America.\textsuperscript{18}

In the first half of the nineteenth century, educators who wished to offer girls domestic science found no available textbooks. This was a serious impediment, given the common practice of basing instruction on recitation from texts. How could one talk about the applications of chemistry to cookery, without knowing the chemical processes involved? Few instructors in secondary schools had the knowledge or background to develop such a course themselves.

Another likely factor in the lack of domestic science in girls' courses of study was the vocational nature of the subject as then conceived. The topics Rush included in his 1787 course, such as preserving vegetables, preparing soups, and providing home remedies for warts, were similar to the sorts of topics some educators recommended in a curriculum geared to children of the lower and farming classes.\textsuperscript{19} Presumably, few middle- and upper-class parents would have found such study attractive in providing their daughters with the refined polish necessary to attain a higher status in society.

While the domestic arts may have seemed excessively
utilitarian and common, science was viewed as fashionable and genteel. Many of the women who developed scientific interests in Great Britain or France during the eighteenth century were from the upper classes. Some discussion of scientific subjects was *de rigueur* for ladies seeking to establish themselves in society. In her salon, the well-bred lady could easily discourse on meteor showers, hydrostatics, or recent developments in pneumatic pumps. Aping the fashions of the aristocracy was undoubtedly common among those seeking increased social status in the United States. For many Americans, some of the urge to give their daughters a traditional scientific education may have been due to this desire for upward social mobility.

Another explanation for the fact that girls' schools preferred to offer experimental demonstrations of steam engines rather than demonstrations of bread-making lies in the nature of the public scientific lectures in the early nineteenth century. Exhibitions of technology had long formed a part of public lectures in natural philosophy. Since the eighteenth century, the American, British, and European public, male and female, enjoyed demonstrations of experiments with magnetism, electricity, and steam. So prevalent were these demonstrations in America, that in the 1840s, the physicist Joseph Henry complained that "every man who can...exhibit a few experiments to a class of young ladies is called a man of science." It is therefore likely that many educators viewed the technology included in
natural philosophy textbooks as a desirable extension of this popular form of scientific entertainment.

Finally, the traditional scientific disciplines served the rhetoric supporting female education far better than did domestic science. As discussed above, many advocates of education for women argued that such training would fit them to be more interesting companions for their husbands, improve their mental discipline, and provide them with the knowledge necessary to teach their children or supervise their schooling. Where was the intellectual rigor in learning to preserve fruits and vegetables? How could a women put such knowledge to use in training her sons? On the other hand, a traditional science education presumably provided grist for mental discipline, gave women the intellectual background to interest their sons in the useful arts of science and technology, and provided husbands with stimulating companions capable of discussing recent scientific developments.

Although the notion of a domestic science curriculum for girls had a small but consistent appeal to some educators, domestic science would not become an institutionalized genre until near the close of the nineteenth century. When the renowned women's educator Catharine Beecher authored a textbook on domestic economy in 1840, many of her contemporaries still questioned the value of a study which dealt with the common concerns of home and hearth. George B. Emerson, a well-known Boston teacher who
endorsed Beecher's text, described the widespread criticism as a "constantly-recurring inquiry, 'What will be the use of this study?'" The social and cultural context of the early nineteenth century led middle- and upper-class Americans to prefer a pure, rather than an applied science for their daughters.

Level of Difficulty

How did the level of difficulty of the science offered to girls compare with that offered to boys? Comparing texts poses a challenge, because the determination of whether or not a text is difficult can be made on the basis of a variety of such categories as vocabulary level, sentence length, number of pages or topics, format, or mathematical complexity. In the ensuing discussion, a textbook's level of difficulty is determined solely on the basis of two categories: format and mathematical complexity. It is within these two categories that texts used by girls seem to have differed, for a period, from those used predominantly by boys.

During the first three decades of the nineteenth century, many of the science texts commonly found in girls' schools used a conversational format. Although she was not the first to organize her content this way, Marcet popularized the conversational style of science writing among those interested in authoring science books for girls. Swiss by birth, Mrs. Jane Marcet (1769-1858) moved to London with her husband Alexander, a wealthy doctor who had retired
to indulge his passion for chemistry. In Britain and Europe, the Marcets numbered some of the best-known scientists among their social circle. Encouraged by her husband, Marcet began to attend public experimental lectures. Because she had no scientific background, she found it difficult at first to follow the rapid pace of the demonstrations. However, by conversing with others on the subjects of natural philosophy and chemistry, and by repeating the experiments at her own leisure, she became increasingly familiar with the principles of these sciences. As she overcame her own difficulties, she endeavored to ease the way for other women whose education was "seldom calculated to prepare their minds for abstract ideas, or scientific language." To this end, she authored several of the most widely-used and influential scientific textbooks in the early nineteenth century.\textsuperscript{24}

Marcet wrote each of her books as a dialogue between "Mrs. B," a refined lady with scientific interests, and her two young disciples, Emily and Caroline. In the course of their conversation, Mrs. B illustrates a variety of concepts through experiment and demonstration. For example, in \textit{Conversations on Natural Philosophy}, Emily asks, "Would not water, as well as ether, boil with less heat if the pressure of the atmosphere were taken off?" After confirming this hypothesis by describing the experiments of De Sassure on Mt. Blanc, Mrs. B. provides a demonstration:
But I can show you a pretty experiment, which proves the effect of the pressure of the atmosphere in this respect.25

The scientific lady, as conceived by Marcet, was far from being a stereotypical blue-stocking. In Marcet's books, Mrs. B represents the ideal female of the Enlightenment: intelligent, sophisticated, and exquisitely refined. Her scientific interests add to her feminine charms, and her knowledge of experimental methods give her a fashionable allure.26 Throughout Marcet's texts the conversational format, in which scientific content was conveyed through the medium of female characters, effectively underlined the naturalness of young women's participation in science.

When Marcet's texts first appeared on the American market, they spawned a host of imitations. Among American authors to use the conversational format was Mary Townsend, sister of the naturalist John Kirk Townsend. In 1844, Townsend published her Life in the Insect World: or, Conversations Upon Insects Between an Aunt and her Nieces. In 1879, Elizabeth Cady Agassiz used a somewhat similar approach in her book on marine life. The wife of the Harvard scientist Louis Agassiz, Elizabeth Agassiz published a natural history of marine flora and fauna in a book addressed to a female readership. Agassiz wrote her text in the form of a letter from Aunt Lizzie to her two nieces, Lisa and Connie. Through the medium of these and other texts, American authors underscored the appropriateness of
Although she wrote for a general female audience, both male and female seminaries widely used Marcet's texts as schoolbooks. In the United States, what can only be called plagiarized or near-plagiarized versions of Marcet's books quickly appeared on the market with adaptations calculated to make the books appealing to educators. For instance, the *Conversations on Natural Philosophy* edited by the Reverend J.L. Blake included questions at the foot of each page to facilitate its use in school examinations. Blake's edition was the most commonly reported natural philosophy textbook in the Massachusetts common schools in 1837.

In the 1830s, use of the conversational format came under attack from a new generation of textbook writers, of whom the best-known and most successful was John Lee Comstock (1787-1858). A surgeon by profession, Comstock served in the War of 1812, having charge of three hospitals on the northern frontier. At the close of the war, he practiced medicine in Hartford, Connecticut, and began to write schoolbooks. The first chemistry textbook published under Comstock's name was an edited version of Jane Marcet's *Conversations on Chemistry*. In 1831, Comstock published his own *Elements of Chemistry*, written in a straightforward prose style. Comstock's new text, arguably the most popular chemistry text in secondary schools before the Civil War, went through more than 50 editions in America, appearing predominantly in male academies.
In *Elements of Chemistry*, Comstock abandoned the conversational format made popular by Marcet, claiming that it was falling rapidly into disuse abroad:

> We learn, that in those parts of Europe where the subject of education has received the most attention, and consequently where the best methods of conveying instruction are supposed to have been adopted, school books in the form of conversations are at present entirely out of use.\(^{32}\)

Other textbook authors targeting the academy market followed suit. For example, in 1840 James Renwick, professor of natural philosophy and chemistry at Columbia College, authored a text in prose format "for the use of schools, academies, and the lower classes of college."\(^{33}\)

Although Comstock did not discuss the issue of gender, the fact that Marcet's popular chemistry text was written as a series of conversations among females must have rendered its use problematic in boys' schools. It is certainly no coincidence that after the appearance of Comstock's text, increasing numbers of boys' secondary schools began to add chemistry to their courses of study in the 1830s. A survey of male academies in North Carolina illustrates this trend (see Table 1); James Mulhern found similar results in his survey of secondary schools in Pennsylvania.\(^{34}\)

As boys' schools turned to the newer textbooks, girls' schools also began to use texts published in the presumably more modern prose format. For instance, Almira Hart Lincoln
Phelps, whose chemistry text appeared three years after Comstock's, used a prose rather than a conversational format. Although dealt a serious blow in secondary schools, the older format lingered throughout the century in materials written for younger children. A few natural history texts, books published for younger children in common schools, and articles written for children's magazines continued to feature the dialogue as a medium of scientific instruction. For example, The Rose Bud or Youth's Gazette featured a running series in the 1830s entitled "The Young Botanists," in which two small boys and an older brother discuss botany as they ramble through the countryside.36

Because relatively few female seminaries provided instruction in advanced mathematics before 1830, the scientific texts used in girls' schools were less advanced

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<th>Year</th>
<th>Number of Schools</th>
<th>Number in Sample</th>
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<td>0</td>
<td>15</td>
<td>0%</td>
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<tr>
<td>1810-1819</td>
<td>1</td>
<td>11</td>
<td>9%</td>
</tr>
<tr>
<td>1820-1829</td>
<td>1</td>
<td>26</td>
<td>4%</td>
</tr>
<tr>
<td>1830-1840</td>
<td>8</td>
<td>20</td>
<td>40%</td>
</tr>
</tbody>
</table>

Source: Data compiled from newspaper advertisements included in North Carolina Schools and Academies, ed. Coon.
mathematically than texts used in boys' schools in the 1830s. This state of affairs began to change during the following decade, as increasing numbers of girls' schools began to include such subjects as geometry, algebra, and trigonometry in their course offerings.\textsuperscript{37}

Although the subject of chemistry was a girls' subject until mid-century,\textsuperscript{38} their lack of advanced mathematics caused girls initially to miss the revolution in secondary school chemistry education occurring in the 1830s. This new departure consisted in requiring students to use chemical notation and formulae to calculate the atomic weight of various compounds. John Comstock was the first chemistry author to introduce chemical formulae to a secondary school audience.

Publishing twenty-six years after Marcet's book initially appeared on the market, Comstock's use of simple formulae represented a radical departure in textbooks designed for secondary schools. The use of symbolic notation had only begun to gain acceptance among American chemists in the early 1830s. Many chemistry textbooks published in the thirties continued either to omit symbolic notation altogether or to use it only in headings and notes. For example, In an 1834 edition of a textbook designed for use in medical schools, colleges, and academies, Lewis C. Beck, professor of chemistry and botany in New York University, made only minimal use of chemical formulae.

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In his preface, he explained that:

Symbols have not heretofore found much favor among our chemists...I at first intended to carry through the press without introducing [symbols], although I had observed that they were employed by several English chemists.39

Refraining from using notation in his text, Beck restricted symbols to subject headings so that "their meaning will at once be understood, and cannot occasion the least embarrassment to the subject."40 The following heading, found in a section on hydrogen and chlorine, is representative of the headings in Beck's text:

Hydrochloric or Muriatic Acid--Atom. Num. 36.45 --
Symb. Cl + H -- sp. gr. 1.269 air = 1

Although American chemists began to apply algebraic formulae to chemical notation in the thirties, the underlying mathematics of early nineteenth-century chemistry was relatively simple. Chemical calculations rarely appeared in textbooks designed for academies and seminaries. According to the historian John Nietz, out of a sample of 12 chemistry texts published between 1784 and 1815, none included chemical calculations; 36 texts published between 1816 and 1865 devoted less than 1 per cent of space to calculations.41 In the few cases where authors did include calculations, students required prior knowledge of only arithmetic and the simpler rules of algebra.

Comstock's text went far beyond Marcet's and even Beck's in its emphasis on chemical nomenclature and the
"laws of definite proportions" discovered by John Dalton (1766-1844) at the beginning of the century. Comstock claimed that "The nomenclature of chemistry, the laws of affinity, and the doctrine of proportions, are far more necessary to a proper knowledge of this science, than is a knowledge of mathematics to the study of astronomy." His readers learned how to calculate the atomic weight of a compound by adding the atomic weights of its elements, and to express such simple calculations as formulae. The following example for nitrous acid is fairly representative:

<table>
<thead>
<tr>
<th></th>
<th>By volume this acid is composed of,</th>
<th>By weight,</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>100</td>
<td>Nitrogen 14</td>
</tr>
<tr>
<td>Oxygen</td>
<td>200</td>
<td>Oxygen 32</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Nitrous Acid</td>
<td>46</td>
<td></td>
</tr>
</tbody>
</table>

In spite of its enormous popularity, sources indicate that Comstock's text did not appear in girls' schools until the 1840s. Instead, female seminaries throughout the thirties appear to have preferred textbooks addressed to a general audience. Such texts omitted symbols, formulae, and calculations, and conveyed the principles of chemistry through description and demonstration. However, although a few female seminaries may have continued to use later editions of Marcet's text after the thirties, textbook listings in newspaper advertisements and school catalogs reveal that as older texts fell increasingly behind the pace
of scientific discovery, some girls' schools turned to new authors who provided more relevant or up-to-date content. The evolving curriculum of Knoxville Female Academy in Tennessee exemplifies the increased rigor in the sciences offered in girls' schools in the 1840s. In 1831, the Academy's course of study for the middle, or junior class included arithmetic, geography, history, natural philosophy, rhetoric, and botany. In 1847, the Academy became the East Tennessee Female Institute. In that year, sophomores studied, among other things, Comstock's natural philosophy, astronomy, chemistry, and mineralogy texts. Juniors were required to study mechanics, hydrostatics, hydraulics, pneumatics, acoustics, electricity, magnetism and optics, natural history, evidences of Christianity, and geology along with languages and literature.46

Several introductory chemistry texts designed for use in colleges appeared in female seminaries in the forties and fifties, including those by John Porter, professor of chemistry in Yale College, James Renwick, professor of natural philosophy and chemistry in Columbia College, textbook author John Johnston, and Alonzo Gray, instructor in Brooklyn Female Academy.47 Of these, Gray's text represents the most advanced use of chemical symbols and notation.48 He used symbols and chemical formulae to a far greater extent than did Comstock, introducing algebraic
formulae to express chemical processes throughout the text:

Notwithstanding the great advantages of the chemical nomenclature, a much greater help is given to the student in the notation. By this, as in algebra, long and intricate processes are exhibited to the eye at a glance.49

Gray's text appeared in numerous editions and was evidently widely used in secondary schools.50

By the 1850s, the most advanced chemistry texts used in female seminaries were no more elementary in content than were the most advanced texts used in male academies during the same period. The great majority of chemistry texts published for use in academies appeared in the educational institutions of both sexes. The few textbooks likely to have been used predominantly in boys' schools included chemical symbols and formulae no more complex than those studied by girls. For example, both Lewis C. Beck's A Manual of Chemistry, and William Henry's The Elements of Experimental Chemistry appear to have been used primarily in male academies. In both cases, the authors stressed a conceptual understanding of chemical principles rather than the use of chemical symbols and formulae.

Although girls' schools began to offer their students mathematically advanced chemistry texts in the forties, most nevertheless seem to have avoided Comstock's text, which continued to be popular in male academies up to and beyond the Civil War. The absence of Comstock's text in most girls' schools is most likely due to the nature of its applied

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science. While Marcet's text, like many others of the period, dealt largely with so-called pure science, Comstock's text included various examples of the applications of chemistry to everyday male life. Comstock related chemistry, not to the female occupations of hearth and home, but to such traditionally masculine occupations as mining, assaying, and tanning. Given its vocational bent, Comstock's text undoubtedly appeared eminently useful to young men. In their practicality, editions published throughout the forties and fifties might even have appealed to those hardy souls hoping to strike it rich in the western gold fields.

Unlike chemistry schoolbooks, which only began to include relatively simple calculations in the 1830s, the more advanced natural philosophy (physics) and astronomy texts written for academies had long required knowledge of higher mathematics. Until girls' schools began to include such subjects as algebra, geometry, and trigonometry in their courses of study in the 1830s and 1840s, their lack of higher mathematics thus served as a barrier to advanced instruction in these sciences.

Natural philosophy and astronomy textbooks appearing in girls' schools before 1840 were very similar to texts developed for popular audiences in Europe and the United States. By the late 17th century, the mathematics of natural philosophy and astronomy was beyond the grasp of all but the most accomplished mathematicians. During this
period, the emphasis in these sciences had shifted from
geometry to algebra and calculus, largely as a result of
efforts to solve problems in mechanics. Textbook authors
g geared their content to the audience served by their texts.
When the intended audience was the general public, most
authors jettisoned the mathematics altogether. The natural
philosophy author explained physical concepts in a
conversational or prose format and may also have referred to
experiments to demonstrate scientific principles; the
astronomy author referred to illustrations within the text.
On the other hand, when the intended audience was a class of
college students preparing to become practitioners or
teachers of natural philosophy or astronomy, textbook
authors introduced some of the mathematical reasoning
underlying each science.

Before 1840, the natural philosophy and astronomy texts
used in girls' schools were almost entirely conceptual in
nature. While students would have required a knowledge of
arithmetic and elementary geometry in order to understand
the examples and illustrations included in these books, they
required no knowledge of algebra or trigonometry.

Some texts likely to have been used in boys' schools
also avoided higher mathematics. For instance, John S.C.
Abbott wrote his astronomy text "for use of schools and the
general reader," assuring his audience that his book did not
include mathematics:

Most treatises upon Astronomy contain much which
is quite unintelligible to those who have not passed through a regular course of mathematical studies.\textsuperscript{53}

Other authors of texts designed for both male and female academies and seminaries made similar statements in their prefaces.\textsuperscript{54} While their introductory texts may not have included higher mathematics, in some institutions, boys had the opportunity to study the sciences at more advanced levels. For example, in 1823, New Bern Academy in North Carolina offered science in both its male and female departments. One of the texts available to both sexes was Marcet's \textit{Conversations on Natural Philosophy}. However, whereas Marcet's was the only text used in the female department, boys in the male department who desired additional scientific study could proceed to the more mathematically complex texts of William Nicholson and Tiberius Cavallo. Although rather outdated, these books required knowledge of plane and spherical geometry and included algebraic analysis in footnotes.\textsuperscript{55}

Before mid-century, a number of textbooks likely to have been used predominantly in male academies included advanced mathematics in their pages. Bartlett's \textit{Elements of Natural Philosophy: Spherical Astronomy}, designed for use in West Point Military Academy, required knowledge of plane and spherical geometry, algebra, and trigonometry. This text contained numerous examples of the applications of astronomy to navigation, geography, and chronology. In 1845, William A. Norton published \textit{An elementary Treatise on Astronomy} for
use in colleges and "the higher academies." Norton's aim was to "furnish the practical astronomer with rules, or formulae, and accurate tables for performing the more important astronomical calculations." 

One of the earliest natural philosophy textbooks appearing in girls' schools to include algebraic formulae was Alonzo Gray's Elements of Natural Philosophy, first published in 1850. Although the title page stated that it was "designed as a text-book for academies, high-schools, and colleges," Gray claimed in his preface to have written his text for the young women under his "immediate instruction" at Brooklyn Female Academy. An example of Gray's algebraic treatment of Newton's Law of Gravitational Force is given below in Plate 4.

At the same time that Gray's text first appeared, a more advanced level of astronomy became available to girls in some educational institutions. In 1850, James M'Intire published New Treatise on Astronomy, a text designed for high schools and academies that required prior knowledge of geometry, algebra and trigonometry. Although M'Intire's text does not appear in the female seminary catalogs and newspaper advertisements used in this study, his opening remarks indicate that he expected or hoped that his book would appeal to both sexes:

Even well-educated females are expected to have added a competent share of astronomical knowledge to the other accomplishments of their sex.
If the formula in the note below be applied to the third example in numbers, the loss of weight will be equal to
\[
\frac{2000(2 \times 4000 \times 500 + 250,000)}{16,000,000 + 2 \times 4000 \times 500 + 25,000} = \frac{8,500,000,000}{20,250,000} = 419\frac{1}{4} \text{ lbs.}
\]

If the height is not more than half a mile, \(x^2\) may be neglected, and then the formula will be
\[
W - W' = \frac{W \times 2x}{r + 2x}.
\]

Fig. 17. *Let \(A\), Fig. 17, be the earth, \(C\) its center, \(x\) the height from the surface, then will the weight at \(s\) be to the weight at \(x\) as the squares of the distances \(Cs\) and \(Cs\). Now, to find the loss of weight, we must subtract the weight at \(s\) from the weight at \(s\), and then, if we represent the weight at \(s\) by \(W\), and at \(x\) by \(W'\); also, \(Cs\) by \(r\), and \(sx\) by \(x\), we shall have the proportion
\[
W : W - W' :: (r + x)^2 : 2rx + x^2, \text{ or } W : W - W' :: r^2 + 2rx + x^2 : 2rx + x^2.
\]

The loss of weight, then, will be
\[
W - W' = \frac{W(2rx + x^2)}{r^2 + 2rx + x^2}.
\]

By 1868, some female academies offered girls texts comparable in their mathematics to the most advanced astronomy and natural philosophy texts used in male academies: E. S. Snell's editions of Denison Olmsted's *An Introduction to Astronomy* and *An Introduction to Natural Philosophy*. Snell, professor of mathematics and natural philosophy at Amherst College, designed these as textbooks "for the use of students in college." These texts required prior knowledge of algebra, geometry, and trigonometry.59
Snell's editions of Olmsted's texts, along with those of Comstock, were widely used in secondary schools.60

Conclusion

This chapter opened with a description of a newspaper advertisement published by Bedford Female Academy, a conservative girls' school that stressed the importance of an ornamental, rather than a scientific education for girls. In order to evaluate the justice of Bedford's charges against rival institutions, they must be interpreted within the social context of the period. The assertion that women should understand more of cookery than chemistry appears to be a reaction against the so-called pure science contained in girls' textbooks. As discussed earlier in the chapter, the lack of attention to domestic science characterized almost every American science textbook used in girls' schools. For some conservative educators, the technological subjects included in astronomy and natural philosophy texts probably seemed unsuited to women's sphere, and potentially damaging to the relation between the sexes.

Bedford's accusation, made in 1837, that the science commonly taught in female seminaries was a "pretended science taught only in name," must be considered in light of the textbooks available to girls before 1840. As discussed earlier, it was only in the forties that texts appeared in girls' schools comparable in their mathematical complexity with those in boys' schools. It is likely that Bedford's
criticism arose from the belief, not uncommon during this era, that a science devoid of mathematics was not a science at all.

The educators at Bedford were not the first to ridicule the notion of teaching science without mathematics. Similar views had been expressed by British author William Enfield, whose textbooks dominated science instruction in American colleges in the early decades of the nineteenth century. In the preface to his *Institutes of Natural Philosophy*, Enfield characterized as effeminate the practice of omitting advanced mathematics from science instruction:

> The hardy perseverance, and the vigorous exertions, which are necessary...are so contrary to that effeminacy and frivolity which distinguish the present age, that if it were not for the provision which is made in our universities...the more abstruse and difficult branches of science would be excluded from the modern system of education, and consequently fall into disesteem and neglect.\(^6\)

Many of the most popular elementary science textbooks appearing at the dawn of the nineteenth century were authored by women for a female audience. It is therefore hardly surprising that the notion of a simplified, non-mathematical science came to be viewed as feminine, and its exposure to male students and use by male teachers as effeminate.

Present-day scholars have repeatedly noted the presence of scientific subjects in girls' courses of study and wondered about the nature of these studies. It is certainly
the case that the sciences offered in girls' secondary schools and coeducational academies—as in all-male academies—were elementary compared to the most advanced subjects offered in colleges. However, the sources examined for this study indicate that after 1840, the most advanced science textbooks offered in female seminaries were comparable to the most advanced texts offered in male academies. As we have seen, the introduction of higher mathematics into girls' schools had an enormous impact on the level of difficulty of the sciences offered to females. Before 1840, textbooks used in girls' schools emphasized a conceptual, rather than a mathematical, understanding of scientific principles, and usually conveyed content through the medium of a conversational format. The shift towards a more advanced study of the sciences was made possible by a revolution in the mathematics education of American girls. How this revolution occurred, and why, is the subject of the following chapter.

Notes

(1) "Bedford Female Academy," in Richmond Enquirer (November 3, 1837).

(2) Thomas Cary Johnson, Jr., Scientific Interests in the Old South (New York: D. Appleton-Century Co., 1936), 106-125. Largely on the basis of subject listings in girls' courses of study, Johnson concluded that Southern women were "remarkably well informed" about science (125); Deborah Jean Warner, "Science Education for Women in Antebellum America," in Isis 69 (1978): 58-67. Warner argued that knowing the identity of the faculty members responsible for science instruction in female schools is indicative of what
science a student might have learned. However, this argument has two serious drawbacks. First, although some science educators in female seminaries were widely esteemed by contemporaries for their scientific knowledge, they nonetheless may have simplified their science curriculum for a female audience. Second, identifying faculty members in female seminaries is problematic because of the lack of extant records; Christie Anne Farnham, The Education of the Southern Belle: Higher Education and Student Socialization in the Antebellum South (New York: New York University Press, 1994). From an examination of the courses and apparatus listed in college circulars, Farnham concluded that female colleges compared favorably with male colleges in the number and level of science courses offered. However, Farnham does not discuss the textbooks used by respective institutions.

(3) I used the following method to distinguish texts likely to have appeared in girls' schools from those likely to have appeared only in boys' schools. From the newspaper advertisements of educational institutions catering to girls in North Carolina, Virginia, Connecticut, and Massachusetts (1794-1850), I constructed a short list of some science textbooks used in girls' schools. To this list, I added titles identified by Thomas Woody in A History of Women's Education in the United States. Woody's list includes the natural philosophy, astronomy, and chemistry textbooks mentioned in the catalogs of more than 162 female seminaries from 1780 to 1870. If a textbook did not appear in the sample thus obtained, and its title page or preface stated that it was designed for use in academies, I inferred that it was likely to have been used primarily in boys' schools. With very few exceptions, most of the textbooks used in female seminaries were also used in male academies. Nevertheless, a few texts, being unmentioned in girls' school advertisements or catalogs, appear to have been used almost exclusively in male academies (see Appendix 1).

(4) See Woody, A History of Women's Education in the United States, 1, 233ff.


(8) Warner, "Science Education for Women in Antebellum
America," 69, 64.


(13) Ibid., 10.


(16) "Boarding School at Lynchburg," in Richmond Enquirer, September 5, 1837. Similar advertisements include: "Serninary for Young Ladies," in Richmond Enquirer, (Oct. 14, 1834); "Miss Mackenzie's Seminary," in ibid. (Sept. 12, 1828); "Federal Hill Seminary," in ibid. (Sept. 23, 1836); "Cumberland Female Seminary," in ibid. (Sept. 12, 1837); For more discussion of the experimental apparatus used in girls' schools, see Deborah Jean Warner, "Science Education for Women in Antebellum America", 58-67; Thomas Cary Johnson Jr., "Sweet Southern Girls," in *Scientific Interests in the Old South*, 106-125.


(18) Miles and Abrahams, *America's first chemistry Syllabus-and-Course for Girls*, 112; 116. The authors state that only one edition is known of Rush's course syllabus. A small pamphlet of eight pages, it is housed in the Library Company of Philadelphia.

(19) For instance, see John de la Howe, "Plan for Establishing Schools in a New Country, Where the Inhabitants are Thinly Settled, and Whose Children are to be Educated With a Special Reference to a Country Life (1789)," in *The American Legacy of Learning: Readings in the History of


(24) Jane Marcet, Conversations on Chymistry (Philadelphia: James Humphreys, 1806), i-ii; Jerome Murch, Mrs. Barbauld and her Contemporaries (1876); Phillips, The Scientific Lady, 110-111.


(26) See Marcet, Conversations on Chymistry; Rev. J.L. Blake, Conversations on Natural Philosophy (Boston: Lincoln and Edmands, 1829). Blake added examination questions to Marcet's original text.

(27) Townsend, Life in the Insect World; Mrs. Agassiz, A First Lesson in Natural History (Boston: Ginn, Heath & Co) 1884 [1879].

(28) In 1806, James Humphreys issued a text entitled Conversations on Chymistry that, except for the name of the author, was virtually identical to Marcet's text. The Reverend J.L. Blake authored Conversations on Natural Philosophy and Conversations on Chemistry, adding examination questions to the two original Marcet texts. Thomas P. Jones published New Conversations on Chemistry, a slight adaptation of Marcet's earlier book. J.L. Comstock authored a version of Conversations on Chemistry, then wrote his own textbook in a straightforward prose format several years later.
This conclusion is based on data compiled from *First Abstract of the Massachusetts School Returns for 1837* (Boston: Dutton and Wentworth, 1838). The data reveal that 70% of Massachusetts towns reportedly used Blake's text in their common schools.


Mulhern, *A History of Secondary Education in Pennsylvania* 328. Mulhern's data is not broken down by decade, but clearly shows an increase in chemistry in boys' secondary schools from 1750 to 1889.

Almira Hart Lincoln Phelps, *Chemistry for Beginners* (New York: F. J. Huntington, 1838 [1834].

For example, see Agassiz, *A First Lesson in Natural History; The Rose Bud or Youths Gazette* (Feb. 16, 1833); *ibid.* (March 2, 1833).

A detailed discussion of girls' evolving mathematics education is found in Chapter 4.

See Tables 2-4 in Chapter 2.

C. Skinner, 1834), title; vi.

(40) Ibid., vi.


(43) Ibid., 143.

(44) Because Comstock's chemistry text does not appear in the sample of girls' school newspaper advertisements and catalogs used in this study, I have inferred that it was in all probability predominantly used in male academies. It was a highly popular text, appearing in numerous editions. Had it been used in many girls' schools, it is likely that it would have appeared in my sample.

(45) For example, see Almira Hart Lincoln Phelps, *Chemistry for Beginners* (New York: F.J. Huntington, 1838 [1834]); John W. Webster, *Manual of Chemistry* (Boston: Richardson & Lord, 1829 [1828]).

(46) From excerpts of the Academy's catalogs, included in Thomas Cary Johnson, *Scientific Interests in the Old South*, 111.


(49) Gray, *Elements of Chemistry*, 134.


(58) James M'Intire, *New Treatise on Astronomy* (New York: A.S. Barnes & Burr, 1860 [1850]), vi. M'Intire's text appeared in a limited number of editions, so it is possible that it was not widely used. This may explain its absence from the school catalogs of female seminaries.


Chapter 4
From Arithmetic to Higher Mathematics

Introduction

In recent years, scholars seeking to account for the low numbers of women in such fields as engineering and physics have pointed to girls' lack of interest and achievement in advanced mathematics. Some researchers have used the term "math anxiety" to describe the nervousness with which many females appear to approach the subject. Some educators and policy makers appear to believe that this state of affairs has always been present in American education. According to one author, "Boys have historically outsored girls in math." Similarly, the American Association for the Advancement of Science reports in a recent document that "In the past, [girls] have largely been bypassed in science and mathematics education."1

Historians have advanced similar arguments. For example, in the 1970s, historian of science Stanley Guralnick suggested that nineteenth-century girls abandoned the study of natural philosophy and astronomy as these subjects became more mathematically complex. According to Guralnick, faculty members in boys' academies realized by mid-century that the study of the sciences necessitated a thorough preparation in algebra, geometry, and calculus. Only the study of natural history was exempt from this requirement, which "rendered natural history a subject peculiarly
suitable for young women, who received little mathematical training.  

Is it true that girls have historically demonstrated a lack of interest and achievement in mathematics? This chapter aims to answer the following questions: 1) How did the mathematics offering in nineteenth-century girls' secondary schools compare with that offered in boys' schools? 2) Did the increasing mathematical complexity of physics indeed induce girls to abandon it as a subject of study? 3) What was the relation between girls' mathematical training and their subsequent choice of scientific study? The discussion begins by tracing the shift from arithmetic to higher mathematics in girls' schools.

From Arithmetic to Higher Mathematics

Few colonial Americans taught arithmetic to girls, because it was assumed that women had no need of it in adult life. William Woodbridge, editor of the American Annals of Education, stated that in the Connecticut schools of the 1770s, girls were taught "rarely even the first rules of arithmetic...I have known boys that could do something in the four first rules of arithmetic. Girls were never taught it."

Written arithmetic was necessary for commerce and bookkeeping; no women, and relatively few men had need of this skill in an era of subsistence agriculture and limited trade. A study of the American Loyalist claims presented in England in the 1770s and 1780s revealed that women typically could not assess the value of their property or testify.

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precisely about the state of their family finances, whereas men could do so in detail. Women's inability to perform these calculations undoubtedly was due to their lack of training in commercial arithmetic and to the culturally pervasive belief that the oversight and regulation of family finances belonged to the affairs of men.

After the Revolution, however, such prominent Americans as Benjamin Franklin, Benjamin Rush, and Noah Webster argued that Americans could benefit from training girls in arithmetic and bookkeeping so that young women could assist their families in business. And as the commercial expansion of the nation at the dawn of the nineteenth century drew more families into business enterprises, it became expedient to allow women the task of keeping the books.

The first educational institution to instruct girls in simple arithmetic was the dame school. Dame schools provided a rudimentary instruction in English to prepare young boys to enter the town grammar schools. Girls also enrolled in these schools, whose curriculum included the alphabet, some spelling, reading, writing, and numbers. To these basic subjects were added knitting and sewing for the benefit of female students.

Another source of arithmetic instruction for girls was the private schoolmaster, or tutor. Although most such instructors catered to boys, offering such subjects as arithmetic, algebra, geometry, trigonometry, surveying, fortification, and so on, a few marketed their services to
girls as well, offering instruction in arithmetic. For instance, in 1766, the Pennsylvania Gazette carried the advertisement of a private instructor offering to teach arithmetic to girls:

The rules of [arithmetic] will be peculiarly adapted to the [female] sex, so as to render them concise and familiar.  

Although it is not known how many received instruction in arithmetic at home, girls also undoubtedly received some such instruction from their mothers or other family relatives; in wealthy families, they may also have received some incidental instruction from their brothers' tutors. For instance, the noted female educator Catharine Beecher (1800-1878) recalled that by the time she reached her ninth year, her mother had given her "some instruction in reading, writing, and arithmetic, and a good deal in drawing and painting."  

The few private schools open to girls during the last quarter of the eighteenth century also offered instruction in arithmetic. For example, Jedediah Morse's school at New Haven, which opened in 1783, offered instruction in arithmetic, reading, English grammar, geography, composition, and needlework. When Maria Smith opened a school in Winchester in 1788, she offered writing and arithmetic at a special hour, in addition to a regular course of instruction that included "reading, spelling, Tambour, Dresden Embroidery, and all Kinds of plain and colored
needlework."  

Whereas the notion of teaching arithmetic to girls received wide support after the Revolution, the idea of teaching girls mathematics was highly controversial. Contemporaries defined arithmetic as the "operations performed by various modes of adding, subtracting, multiplying, or dividing." Mathematics, on the other hand, included such seemingly esoteric subjects as algebra, geometry, trigonometry, and calculus. According to the Reverend John Bennett of Massachusetts, opening the doors of mathematics to girls "was attempting to make them move in a sphere, for which Nature never gave them talents, nor Providence designed them." Almira Hart Lincoln Phelps, a nineteenth-century advocate of higher mathematics education for women, noted that even England's famed Hannah More, in her famous *Strictures on Education* (1799) "did not dare to speak of instructing women in the higher branches of mathematics."  

Aside from the fact that such study was traditionally viewed as the prerogative of males, there are a number of other reasons why higher mathematics was not included in the curricula of girls' schools at the dawn of the nineteenth century. First, the rationales that advocates of women's education often advanced for increasing the rigor of girls' studies could be satisfied by the study of arithmetic or the sciences, subjects that were far less controversial for women than geometry or algebra. By promoting mental
discipline, arithmetic and conceptual science\textsuperscript{16} presumably developed the female mind, thus producing a more efficient class of wives and mothers.\textsuperscript{17} Additionally, while many reformers argued that women needed a solid education in order to better serve as teachers, during the late eighteenth and early nineteenth centuries, the vast majority of female teachers worked in primary schools where the limited curriculum required that they teach arithmetic, not higher mathematics.

Another reason mathematics was not commonly offered to girls in the late eighteenth and early nineteenth centuries was the vocational nature of the subject. Knowledge of algebra, geometry, trigonometry, and even calculus was necessary to those seeking careers in such fields as surveying, navigation, or the military. Of course, such vocations were traditionally male, whereas the doctrine of woman's sphere identified the home as the occupational center for women. While the ability to perform simple calculations may have been useful, knowledge of geometry or algebra was deemed unnecessary for women's domestic work.

While reformers could argue that knowledge of the sciences rendered women interesting conversationalists and companions for their husbands, one could hardly advance the same arguments about higher mathematics. Moreover, unlike the sciences, higher mathematics did not enjoy a popular recreational or cultural appeal among middle-class Americans. Few Americans would have flocked to hear public
lectures on algebra or calculus, because the mathematics involved was far beyond the grasp of the average man or woman. What husband, returning home exhausted after a day at business, would wish to converse with his wife about functions or quadratic equations?

Finally, the study of mathematics conferred a collegiate status on the educational institution offering it. Although knowledge of geometry or algebra was not required for admission to many American colleges in the early nineteenth century, young gentlemen would have expected to encounter such subjects among their collegiate studies. Because colleges were closed to women during this period, it was not considered necessary or desirable for girls to pursue such higher studies in the lower institutions available to them.

Nevertheless, in spite of opposition, a movement to include higher mathematics in girls' studies began to appear in female seminaries, prompted largely by a desire on the part of some influential educators to elevate the status of women's education. Although she was not the first to teach higher mathematics to girls, her contemporaries generally credited the well-known female educator Emma Willard (1787-1870) with having initiated this movement. Willard's efforts to bring higher mathematics to American girls seems to have arisen from a desire to obtain a collegiate status for girls' secondary schools. Willard herself stated that she developed the idea of "effecting an important change in
education by the introduction of a grade of schools for women, higher than any heretofore known.\textsuperscript{19}

For the most part, Willard was self-taught in mathematical subjects. After opening her first school for girls in Middlebury, Connecticut, in 1807, she began to teach herself geometry. Having begun Euclid, she requested assistance from her husband's nephew, then a senior in college, stating:

\begin{quote}
I have gone through twenty-nine propositions of the first book of Euclid. I am delighted with the study, and I see no insurmountable difficulties; but I wish you would take the book and see whether I understand it as you do.\textsuperscript{20}
\end{quote}

After a subsequent examination, Willard received assurance that her understanding was correct, and proceeded through Euclid without further help.

In 1818, Willard removed to Waterford, New York, where she opened a girls' school and shocked the local community by teaching geometry to her students. The successful public examination of her first pupil in the subject caused a great deal of excitement, although several of those in attendance claimed that the young woman's accomplishment was due entirely to feats of memory, "for no woman ever did, or could, understand geometry."\textsuperscript{21}

While at Waterford, Willard began to study algebra. Initially, she received three or four lessons from a private instructor, but upon discovering that her instructor knew little of the subject, she began to study it independently.
Step by step, as she learned higher mathematics herself, she proceeded to teach it to her students. As a contemporary related:

In this manner she learned and afterwards taught her students, one class at a time, through Euclid, including trigonometry...algebra, conic sections, and Enfield's Institutes of Natural Philosophy.22

Willard laid great emphasis on mathematics, which she was later to view as epoch-making in the history of American women's education.23 In the spring of 1821, she left her incorporated academy at Waterford and moved to Troy, New York, where she established a female seminary and began to train teachers.24 At Troy, it was her custom to study a mathematical subject, teach it to a class of students, and then turn the teaching of the subject over to one of her most able students, leaving herself free to develop competency in another subject.25

The practice of training female students to be mathematics instructors was motivated in part by financial expediency. It would have cost Willard more than twice as much money to hire educated men to teach the higher branches of algebra and geometry.26 Still another reason for using females to teach mathematics was that, having mastered the subject themselves without having had much formal preparation, Willard believed that women were more sympathetic to female students, more patient, and more innovative in developing teaching methods suited to
beginners, girls who were historically presumed to have no mathematical aptitude.27

Word soon spread of Willard's work at Troy Female Seminary. According to Catharine Beecher, she and her sister had heard of Willard's innovations when they established began a school for young ladies in Hartford, Connecticut in 1823:

At this time I heard that Mrs. Willard and one or two others were teaching the higher branches, but I knew nothing of their methods.28

Beecher and her sister were quick to follow suit. The next year, a newspaper advertisement for their school announced that among the books to be used were Day's Algebra and Euclid's Elements of Geometry.29

The books published by Emma Willard's sister, Almira Hart Lincoln Phelps, also helped to build public support for the new curriculum.30 In one of her best-known books, Lectures to Young Ladies (1833), Lincoln Phelps informed her readers that the study of mathematics would improve their mental discipline and thus better qualify them for the discharge of their womanly duties. By the third decade of the nineteenth century, the attitude of many Americans towards mathematics instruction for girls had so changed that Phelps felt confident that the former opposition to such study had melted away:

Our sex...have been thought deficient in reasoning powers...advantages are now placed before them; they may prove the strength of their reasoning
powers, in the study of mathematics, of logic, and even metaphysics, without fear of reproach for attempting to pass the limits, which nature has assigned for the operation of their minds.31

Historians have noted the widespread dissemination of newer ideas of women's education through the medium of the graduates of Troy Female Seminary.32 In the 1830s, it was fairly common for girls' schools in North Carolina to announce the arrival of a new faculty member from Troy as a means of enhancing their prestige. The 1837 advertisement of Scotland Neck Female Seminary is representative:

The entire control of this Seminary will hereafter be entrusted to [Miss Eugenia Hanks'] care...her qualifications are believed to be of the first order, having finished her education at Mrs. Willard's celebrated school.33

Although the addition of a teacher trained at Willard's famed seminary did not guarantee the inclusion of higher mathematics in the curriculum, in some cases girls' schools added courses in algebra or geometry almost immediately after Troy graduates joined their ranks. For example, North Carolina's Northampton Female Academy listed mathematics in its advertised course of study the year that Miss Harriet A. Dellay, a Troy graduate, joined the Academy.34 As a subject listing, mathematics usually denoted the use of a compendium text that included advanced arithmetic along with such additional subjects as algebra, plane geometry, or conic sections. Phillips' Female Seminary at Chapel Hill, which
opened under the superintendency of Mrs. Phillips and her assistant, a graduate of Troy Seminary, offered its students instruction in arithmetic and Euclid in 1836. Two years later, Phillips' Seminary added algebra to its course of studies.35

While the notion of teaching mathematics to girls gradually gained acceptance, it was not universally approved. When Illinois' Jacksonville Female Academy opened in 1833, a delegation of women visited its director to advise her that if young ladies "can read and spell, write and count, it is all they need to know."36 Some educators in girls' schools, opposed to the new trend, argued that "[girls] should understand practical arithmetic, though not mathematics."37

In spite of such scattered opposition, growing numbers of girls' schools began to offer higher mathematics after the twenties (see Table 1). Based on an examination of the school catalogs of 162 female seminaries from at least twenty states, the historian Thomas Woody concluded that after 1840, arithmetic served as a preparatory subject to more advanced studies. According to Woody, algebra appeared in the 1820s and plane geometry slightly earlier.38

By using such sources as school catalogs and newspaper advertisements, it is possible to compare the course offerings in boys' secondary schools with those in girls' schools. During the first two decades of the nineteenth century, the mathematics instruction in Pennsylvania and
North Carolina girls' schools consisted primarily of arithmetic (see Table 2). While it is the case that a few of the larger arithmetic textbooks published

Table 1
Percentage of Female Secondary Schools Offering Mathematical Subjects, 1749-1871

<table>
<thead>
<tr>
<th>Subject</th>
<th>1749-1829</th>
<th>1830-1871</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(55 schools)</td>
<td>(107 schools)</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>86%</td>
<td>79%</td>
</tr>
<tr>
<td>Algebra</td>
<td>15%</td>
<td>83%</td>
</tr>
<tr>
<td>Plane Geometry</td>
<td>27%</td>
<td>79%</td>
</tr>
<tr>
<td>Plane Trigonometry</td>
<td>2%</td>
<td>40%</td>
</tr>
</tbody>
</table>


Table 2
Percentage of Pennsylvania and North Carolina Male and Female Secondary Schools Offering Mathematical Subjects, 1750-1840

<table>
<thead>
<tr>
<th>Subject</th>
<th>Male Schools</th>
<th>Female Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(91 schools)</td>
<td>(78 schools)</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>63%</td>
<td>81%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>52%</td>
<td>3%</td>
</tr>
<tr>
<td>Algebra</td>
<td>25%</td>
<td>4%</td>
</tr>
<tr>
<td>Geometry</td>
<td>26%</td>
<td>8%</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>9%</td>
<td>1%</td>
</tr>
<tr>
<td>Navigation</td>
<td>11%</td>
<td>--</td>
</tr>
<tr>
<td>Surveying</td>
<td>20%</td>
<td>--</td>
</tr>
</tbody>
</table>


in America included some algebraic content, such content was usually restricted to a small section, often included at the end of the book. There is no way of knowing how many girls
might have studied the introductory algebra contained in such texts. After 1830, while girls' schools still lagged somewhat behind boys' schools in offering trigonometry, the numbers of girls' and boys' schools offering algebra and geometry were roughly equal (see Table 3).

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Male &amp; Coeducational Schools (116 schools)</th>
<th>Female Schools (90 schools)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arithmetic</td>
<td>74%</td>
<td>90%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>21%</td>
<td>--</td>
</tr>
<tr>
<td>Algebra</td>
<td>67%</td>
<td>69%</td>
</tr>
<tr>
<td>Geometry</td>
<td>63%</td>
<td>67%</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>35%</td>
<td>22%</td>
</tr>
<tr>
<td>Navigation</td>
<td>14%</td>
<td>--</td>
</tr>
<tr>
<td>Surveying</td>
<td>47%</td>
<td>--</td>
</tr>
</tbody>
</table>

Source: Data compiled from James Mulhern, A History of Secondary Education in Pennsylvania, 328-9; 428-9.

A shift toward increased offerings in higher mathematics also occurred in boys' schools. Before 1840, only a minority of male academies in Virginia offered instruction in algebra or geometry as separate subjects, although roughly half provided instruction in what was called "mathematics" (see Table 4). The mathematics texts of this period were omnibus texts that often included sections devoted to arithmetic, algebra, geometry, and sometimes trigonometry, mensuration, or even surveying. For example, John Ward's text, The Young Mathematician's Guide.
was divided into five parts: arithmetic, algebra, geometry, conic sections, and "the arithmetic of infinities."

Table 4
Percentage of Virginia Male and Female Secondary Schools Offering Algebra and Mathematics, 1835-1837

<table>
<thead>
<tr>
<th></th>
<th>Male Schools</th>
<th>Female Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(30 schools)</td>
<td>(27 schools)</td>
</tr>
<tr>
<td>Mathematics</td>
<td>57%</td>
<td>7%</td>
</tr>
<tr>
<td>Algebra</td>
<td>17%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Source: Data compiled from newspaper advertisements in The Richmond Enquirer, 1835-1837.

While such mathematical subjects as algebra, geometry, and trigonometry gained acceptance in girls' schools, those associated with male vocations, such as navigation and surveying, did not. Navigation and surveying do not appear in the above sample of Pennsylvania and North Carolina girls' schools before 1840, nor do they appear in the sample of Pennsylvania girls' schools from the later period, 1830-1889. In his study, Thomas Woody noted that surveying and navigation occurred principally in schools for both sexes. We can infer that these subjects were probably rarely, if ever, studied by girls. Throughout the century, the mathematics included in these vocational subjects provided boys with additional practice in advanced mathematics that, by virtue of cultural prejudice, was unavailable to girls.

By 1880, it appears that roughly equal numbers of boys' and girls' academies and seminaries offered algebra and
geometry to their students. Similar developments occurred in the nation's few publicly-supported high schools at mid-century. Although perhaps initially motivated by a desire to elevate the status of women's education, the movement to instruct girls in mathematics was also advanced by a very practical and pressing need for female teachers and teaching assistants in the publicly supported grammar and high schools.

During the same period that higher mathematics entered the curricula of private schools serving the children of well-to-do families, such subjects as algebra and geometry began to appear in the highest grades of some common schools as well, where they became available to girls from a wider range of class backgrounds. The case of the Boston common schools illustrates some of the financial and administrative concerns that beset a city grappling with the issue of offering advanced studies to girls. In practice, the policy decisions made by Boston's School Committee resulted in greater numbers of girls than boys studying bookkeeping, algebra, and geometry in Boston's grammar (upper-elementary grade) schools in 1845, as shown in Table 5. At the time, algebra and geometry were elective subjects. Geometry was taught only in the Hancock and Bowdoin schools, both of which catered solely to girls:

[Algebra and geometry are] permitted in such cases as thought expedient. For this reason algebra is studied in only about two-thirds of [schools], and geometry in two, viz: the Hancock and Bowdoin.45
More girls than boys studied higher mathematics in Boston's grammar schools, because school authorities allowed girls to remain in grammar school up to age sixteen, whereas boys were dismissed at age fourteen. As a result, greater numbers of girls than boys reached the higher classes, where instruction in algebra and geometry was provided. This arrangement originated seventeen years earlier, when Boston's short-lived High School for Girls was closed in

Table 5
Percentage of Students in the First Class of the Boston Grammar Schools Studying Bookkeeping, Algebra, and Geometry, 1845

<table>
<thead>
<tr>
<th>Female Schools</th>
<th>Number in the First Class</th>
<th>Number Studying Bookkeeping</th>
<th>Number Studying Algebra</th>
<th>Number Studying Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowdoin</td>
<td>113</td>
<td>60 (53%)</td>
<td>75 (66%)</td>
<td>25 (22%)</td>
</tr>
<tr>
<td>Wells</td>
<td>77</td>
<td>35 (46%)</td>
<td>35 (46%)</td>
<td>0</td>
</tr>
<tr>
<td>Franklin</td>
<td>40</td>
<td>9 (23%)</td>
<td>11 (28%)</td>
<td>0</td>
</tr>
<tr>
<td>Hancock</td>
<td>100</td>
<td>51 (51%)</td>
<td>38 (38%)</td>
<td>38 (38%)</td>
</tr>
<tr>
<td>Johnson</td>
<td>113</td>
<td>30 (27%)</td>
<td>27 (24%)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>443</td>
<td>185 (42%)</td>
<td>186 (42%)</td>
<td>63 (14%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Male Schools</th>
<th>Number in the First Class</th>
<th>Number Studying Bookkeeping</th>
<th>Number Studying Algebra</th>
<th>Number Studying Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brimmer</td>
<td>40</td>
<td>19 (48%)</td>
<td>19 (48%)</td>
<td>0</td>
</tr>
<tr>
<td>Eliot</td>
<td>80</td>
<td>27 (34%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adams</td>
<td>72</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mayhew</td>
<td>54</td>
<td>0</td>
<td>18 (33%)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>246</td>
<td>46 (19%)</td>
<td>37 (15%)</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Data compiled from Otis W. Caldwell and Stuart A. Courtis, Then and Now in Education, 1845-1923, 222-226.
1828. Because the story of the High School for Girls illustrates the difference in the educational aims of the two sexes, it is worth recounting briefly here.

In 1826, Boston opened a high school for girls, ostensibly to promote the moral and intellectual development of Boston's females, to better prepare them for marriage and motherhood, and to train teachers for the city's primary schools. The experiment was so successful that 130 pupils out of 286 candidates enrolled. The high number of students the first year, and the even larger number of girls who sought entrance the next, stunned members of the city School Committee, who noted that "The High School for boys has been in operation ever since 1821, and in every respect has been successful...yet the greatest number of applicants for admission which ever offered was ninety."47

Because smaller numbers of boys enrolled in high school, and most left school to seek employment before the end of the full course, the city incurred relatively little expense in providing secondary education to boys. According to a Committee report:

The number of those annually admitted into [the High School for boys] is constantly and rapidly diminishing, every successive year, as the parents of scholars are able to find places to put them out as apprentices, or in counting houses. So that the fact is that the greatest number of these who have continued through their whole course is seventeen,--and they belonged to a class consisting originally of about seventy members."48

Taken aback by the large numbers of girls who sought
admission to the new Girls' High School, and cognizant of the fact that the girls, unlike the boys, would most likely continue throughout the entire high school course, the Committee voted to close the school in 1827.49 With the closing of the Girls' High School, however, the School Committee adopted a series of resolutions by which girls were allowed to continue in the city's grammar schools two years longer than the boys. Whereas boys were dismissed at fourteen, girls could remain up to age sixteen. At the same time, the Committee recommended introducing the higher branches previously taught in the Girls' High School into the grammar schools.

Although boys had the opportunity to continue their studies in high school, it is unlikely that there were significantly greater numbers of boys studying higher mathematics than girls in Boston, even were the high-school population added to that of the grammar schools. The reason lies both in the nature of Boston's high schools and in the boys' secondary school attendance. In Boston, boys had the choice of two schools: the Public Latin School, or the English High School. The Public Latin School aimed to prepare boys for college. In 1858, the Boston School Committee reported that at this institution, "the greatest part of the time is devoted to the teaching of the Greek and Latin languages." While the English High School emphasized higher mathematics in its course of study, the Committee lamented that "too small a number enter it annually from the
Grammar schools, and of this number too many leave before completing the regular course of study." So anxious were boys to enter employment, that few were willing to stay and complete the course.⁵⁰

By 1847, Boston's grammar schools offered the same studies to boys and girls, a practice that was supported by the majority of Bostonians but opposed by a vocal minority. The writer of the report of the examination committee, Joseph M. Wightman, was one who complained that the branches of higher mathematics were unnecessary for girls:

Many portions of arithmetic and the whole of algebra, are as unnecessary to female education in our Grammar Schools, as would be the science of engineering, or a course of law studies.⁵¹

Instead, suggested Wightman, girls should be taught habits of industry and economy through instruction in plain sewing. Given sufficient needlework, Wightman believed that in time "the ambition of the pupils will be, to excel in this most legitimate of female avocations."⁵²

In spite of such opposition, Boston continued to offer algebra and geometry to girls in its grammar schools, and in 1852, the city established a Girls' High and Normal School to prepare the teachers who were increasingly needed, not just in the primary schools, but in the grammar schools as well. During this period, financially strapped school boards across the country perceived the desirability of hiring female assistants to teach under a male master at their grammar and high schools.⁵³ Because the salaries paid to
female teachers was often less than half that paid to males, it was far less expensive to hire women, a point driven home by the prominent educator Henry Barnard in 1856:

> As the compensation of female teachers is less than one half that paid to males, every instance of the employment of a female teacher in place of a male teacher in the district school, will save one half of the wages paid to the latter.54

At the time Barnard and other reformers exhorted educators nationwide to consider the benefits of hiring female teachers, several coeducational high schools already boasted female teachers of mathematics, whose classes included boys as well as girls. During his visit to the United States during the 1840s, the Swedish writer Per Siljestrom observed that the mathematical lessons in Hartford High School in Connecticut were given by a female teacher. Siljestrom claimed that "[this] is, indeed, frequently the case in the United States."55

During the Civil War years, school boards became acutely conscious of the desirability, even the necessity, of hiring female teachers, when men were not only expensive, but scarce. According to the Reverend Fraser, a British commentator, the "effect of the war was not to close the schools, but merely to transfer them to the management of women instead of men."56 In Richland County, Wisconsin, the state inspector in 1862 witnessed a reduction in the number of male teachers and the disappearance of larger boys from schoolrooms. The older female pupils also withdrew from
their studies to "supply the lack of teachers."  

Like Emma Willard several decades earlier, some of the first female mathematics teachers in mixed secondary schools had to bring themselves quickly up to scratch in their subjects in order to teach effectively. The letters of Mary A. Dodge, also known as Gail Hamilton, a teacher at Hartford High School, provide a glimpse of the effort required of a female teacher engaged to provide instruction in a variety of subjects, including algebra and geometry:

I have five classes: three in Latin, one in Algebra, and one in Geometry...Algebra is so familiar to me that I do not study it at all out of school...[after Latin] comes a class in geometry. This I need to study, but do it when I am not employed, the hour after Algebra...  

Fueled by the demand for female teachers to teach algebra and geometry in secondary schools, and supported by the rationale of increased mental discipline, increasing numbers of girls' schools began to include higher mathematics in their courses of study. Monticello Female Seminary, which opened in Illinois in 1838, was one of many whose officials justified the study of advanced mathematics as a means of disciplining the female mind. The writer Lucy Larcom, a former student at the seminary, recalled her struggles to attain the discipline that only trigonometry and conic sections could provide:

I had a natural distaste for mathematics, and my recollections of my struggles with trigonometry and conic sections are not altogether those of a
conquering heroine. But my teacher told me that my mind had need of just that exact sort of discipline, and I think she was right.59

Because many nineteenth-century Americans considered mathematics a male domain, the subject was thought to pose great difficulties for girls, but several contemporary reports indicate that this was not the case. The principal of the coeducational Woodward High School of Cincinnati wrote in 1859 that visitors often asked "if the girls equal the boys in the severer branches, such as Geometry." Clearly they did, he replied: on the mathematics exam, the eight girls averaged "86 [and] 37/176 percent, whilst that of the ten boys was 85 and 21/23 percent."60 In some other secondary schools, girls' reported mathematics achievement exceeded that of boys. For example, in 1854, the principal of the Cleveland High School reported that "the first class of girls permitted to take the full course in mathematics stood considerably higher, on the average, than the boys."61 In an 1865 report designed to create support for Indiana's practice of hiring increasingly greater numbers of female teachers, Joseph J. Bingham, State Superintendent of Public Instruction, particularly emphasized women's aptitude for mathematics:

Some of the best mathematicians I have ever taught were females. The best algebraist that ever recited to me was a female, who had earned with her needle, in a tailor's shop, the means of paying her expenses, and educating herself...the best reciter of geometry I ever saw, was a fair young girl, of beautiful person and delicate sensibilities.62
More than fifty years later, Walter S. Monroe reported a study of failure rates by sex in Indiana city and rural schools, concluding that "the boys are much less successful than the girls...even in mathematics the girls show a slight superiority." And in 1910, the principal of Central High School in Cleveland, Ohio, reported that there were as many girls as boys enrolled in a class set aside "for those who are really stars in mathematics...who are eager for all the original investigation and demonstrative work that may be given to them."

Because the most advanced natural philosophy and chemistry textbooks in use in secondary schools by the end of the century required prior knowledge of algebra and geometry, the fact that girls now had equal access to such subjects meant that they were equally prepared to undertake the study of the mathematical sciences in their secondary schools as were boys. Enrollment statistics compiled in 1890 bear this out. In coeducational public high schools, roughly equal numbers of boys and girls enrolled in such courses as algebra, geometry, physics, and chemistry, with girls having a slight enrollment advantage (see table 6). The historians David Tyack and Elizabeth Hansot report that individual school reports reveal the same pattern of similar course enrollments among boys and girls in coeducational schools.
Table 6
Percentage of Males and Females Enrolled in Certain High School Subjects, 1890

<table>
<thead>
<tr>
<th>Subject</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>22.5%</td>
<td>23.2%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>9.9%</td>
<td>10.4%</td>
</tr>
<tr>
<td>Algebra</td>
<td>45.3%</td>
<td>46.0%</td>
</tr>
<tr>
<td>Geometry</td>
<td>21.7%</td>
<td>21.3%</td>
</tr>
</tbody>
</table>


Because researchers often look at self selection as an indicator of gender preference, comparing the percentages of men and women who taught algebra or geometry in high schools reveals the extent to which these subjects were culturally construed as appropriate for males or females. While girls may have enrolled in high-school algebra and geometry classes to fulfill graduation requirements, the numbers of young women who went on to become high school mathematics teachers made this choice freely, unencumbered by similar requirements. Nor were there financial incentives to take up the subject of mathematics; nineteenth and twentieth-century high school teachers of mathematics were no more highly paid than were teachers of English or history.

A study of the teachers providing instruction in algebra and geometry in Wisconsin public high schools reveals that roughly equal numbers of men and women taught these subjects. From 1915 to 1928, school inspectors visited the high schools, observing classes, noting the instructor's name and the subject taught, and providing a
brief evaluation. Thus, the reports of the inspectors indicate the gender of those teaching various subjects. While certain subjects were strongly divided along gender lines, mathematics was not. Unlike physics, which was almost universally taught by men, or English, which was almost always taught by women, mathematics was taught by both sexes, as shown in Table 7.

Table 7
Percentage of Male and Female Wisconsin High School Teachers Responsible for Teaching Selected Subjects, 1915-1928

<table>
<thead>
<tr>
<th></th>
<th>Algebra</th>
<th>Geometry</th>
<th>English</th>
<th>Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1915-16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 schools</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Teachers</td>
<td>50%</td>
<td>76%</td>
<td>4%</td>
<td>97%</td>
</tr>
<tr>
<td>Female Teachers</td>
<td>50%</td>
<td>24%</td>
<td>96%</td>
<td>3%</td>
</tr>
<tr>
<td>1919-20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 schools</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Teachers</td>
<td>31%</td>
<td>66%</td>
<td>9%</td>
<td>93%</td>
</tr>
<tr>
<td>Female Teachers</td>
<td>69%</td>
<td>34%</td>
<td>91%</td>
<td>7%</td>
</tr>
<tr>
<td>1923-24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 schools</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Teachers</td>
<td>55%</td>
<td>36%</td>
<td>13%</td>
<td>100%</td>
</tr>
<tr>
<td>Female Teachers</td>
<td>45%</td>
<td>64%</td>
<td>87%</td>
<td>0</td>
</tr>
<tr>
<td>1927-28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38 schools</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Teachers</td>
<td>62%</td>
<td>55%</td>
<td>0</td>
<td>92%</td>
</tr>
<tr>
<td>Female Teachers</td>
<td>38%</td>
<td>45%</td>
<td>100%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Source: Data compiled from Department of Public Instruction Office of the State Superintendent High School Inspection Reports [Wisconsin], Wisconsin State Historical Society (hereafter WSHS), boxes 1-4.

In California, the demand for mathematics teachers at the secondary level encouraged young women to pursue
mathematics both as an undergraduate and graduate study. At Stanford University, although few students graduated each year with a bachelor of arts degree in mathematics, a large proportion of the mathematics degrees conferred were awarded to women, as shown in Table 8 below. The percentages are all the more significant when considered in light of the proportion of female enrollment at Stanford. In 1899, women comprised 40 per cent of students, a number that seemed to portend the impending feminization of the University. Wishing to maintain the University's reputation as an institution "primarily for men," Mrs. Leland Stanford established a limit on enrollments, such that "The number of women attending the University as students shall at no time

Table 8

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Number of Degrees</th>
<th>Percentage of Female Students</th>
<th>Degrees to Men</th>
<th>Degrees to Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>1892</td>
<td>2</td>
<td>25%</td>
<td>100%</td>
<td>0</td>
</tr>
<tr>
<td>1897</td>
<td>3</td>
<td>37%</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>1902</td>
<td>3</td>
<td>35%</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>1907</td>
<td>3</td>
<td>30%</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>1912</td>
<td>4</td>
<td>28%</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>1917</td>
<td>7</td>
<td>23%</td>
<td>29%</td>
<td>71%</td>
</tr>
<tr>
<td>1922</td>
<td>7</td>
<td>14%</td>
<td>29%</td>
<td>71%</td>
</tr>
<tr>
<td>1927</td>
<td>14</td>
<td>11%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>1932</td>
<td>10</td>
<td>13%</td>
<td>60%</td>
<td>40%</td>
</tr>
</tbody>
</table>

Source: Data compiled from the Leland Stanford Junior University Annual Registers.

ever exceed 500." Thus, during the years from 1899 to 1932, when the trustees rescinded the enrollment limit, women
comprised an increasingly smaller proportion of students. During the academic year 1911-1912, when women received 75 per cent of the Bachelor of Arts degrees in mathematics, they comprised less than a third of the undergraduate student body. Nor, in later years, did the number of women in mathematics decline in proportion to their enrollment at Stanford; in 1932, the percentage of women receiving degrees in mathematics was three times the percentage of women in the overall student body.

A similar pattern can be seen in mathematics degrees awarded at the land-grant University of California in Berkeley, and at the University of Wisconsin in Madison. At Berkeley, bachelor of science degrees in mathematics were awarded in the College of Natural Sciences, which described its curriculum in 1902 as distinguished by "the prominence given to the Natural Sciences as elements of culture, and the preparation afforded for a professional career in science." The 1907 Register specified the fields in which degrees were awarded, revealing that women received 15 of the 18 bachelor of science degrees awarded in mathematics. In 1911, all 9 of the bachelor of science degrees in mathematics were awarded to women, as were two of the three master of science degrees in mathematics. The Commencements published by the University of Wisconsin reveal a similar trend.

Within the context of their culturally approved vocational career paths, women actively pursued the study of
Of course, men continued to dominate such traditionally male fields as engineering and mining, studies which also required advanced mathematics. The almost complete absence of women in college engineering classes has probably more to do with cultural views of gender roles than with the underlying mathematics of the discipline. Far from shunning mathematics, women pursued the subject in their preparation for secondary school teaching.

**Criticism of the Mathematical Girl**

Although increasing numbers of girls studied higher mathematics as the nineteenth century progressed, the controversy surrounding such study never disappeared. Unlike their seventeenth- and eighteenth-century counterparts, who had debated whether females were capable of rational thought, few nineteenth-century American educators upheld the view that girls were incapable of studying mathematics. Instead, critics argued that such study was inappropriate for girls because of its limited usefulness in woman's sphere. For example, in 1865, S. S. Randall, city school superintendent of New York, criticized New York's practice of enrolling girls in the same mathematical course as boys. According to Randall, the study of needlework would be far more practical for girls than advanced mathematics:

> Except as a mere mental discipline [higher mathematics] is wholly unavailable for any useful
purpose in the ordinary transactions and duties pertaining to the sphere of womanhood..."72

The evident mathematical superiority of girls over boys alarmed some schoolmen. In Groveland, Massachusetts, the school committee noted with concern that girls attended the town's common and high schools more regularly than boys, remained longer in the school course, and achieved higher marks in mathematics:

Every register and examination proves it. Our best mathematicians are not those who, if the present order of the world continues, will have occasion to use such knowledge. The fact should awaken serious inquiry.73

Americans did not consider mathematics to be a useful study for females who were presumed destined to become homemakers. In a well-publicized criticism of female education, Horace Greeley expressed dismay at the sight of girls "studying algebra and trigonometry and logarithms" in public high schools when their time might be better spent studying subjects that "they will urgently need to know." In Greeley's opinion, girls of all classes would have derived much greater benefit from learning to cook.74

In 1914, E. R. Breslich of the University of Chicago High School noted a recurring demand that girls be allowed to graduate from high school without any algebra. According to Breslich, the question had been "discussed throughout the country by parents and teachers, by administrative officers, and professors of education." Breslich felt that the main
question was not whether algebra was more difficult for girls than for boys; in his own experience, he had found that girls often excelled boys in algebra. Rather, the opponents of algebra denied that its study was of value to young females. Dr. J. H. Francis, superintendent of the Los Angeles schools, caused a stir during the National Education Association meeting that year when he was said to have exclaimed, "God bless the girl who refuses to study algebra. It is a study that has caused many a girl to lose her soul." Dr. Francis reportedly recommended replacing algebra with courses in costume designing for girls.75

In the early twentieth century, an intensified debate over the role of higher mathematics in girls' schooling, coupled with the introduction of vocational classes in the curricula of many public high schools, fueled a series of reforms leading to declining enrollments among girls in advanced mathematics courses. Such reforms would occur within the context of a number of social and cultural developments which are considered in detail in Chapter Eight.

Conclusion

The current concerns over gender, science, and mathematics raise two controversial questions. First, to what extent does either culture or biology influence girls' mathematics achievement? Second, what is the relation between girls' mathematical ability and their pursuit of a career in such fields as physics or engineering? Recent
scholarship has challenged assumptions, advanced in the
sixties, that girls have inherently weaker mathematics
ability than boys. It has been suggested that culture plays
a key role in shaping girls' perception of mathematics as a
possible field of worthwhile endeavor.76

The historical evidence examined in this chapter
supports the view that culture indeed plays a determining
role in girls' selection of mathematics as a subject of
study and in girls' mathematics achievement. Were inherent
biological traits the determining factor in girls'
mathematics achievement, we should expect to find consistent
evidence in the historical record of girls' lower
achievement when compared to boys. However, this is not the
case. During the middle decades of the nineteenth century,
when girls were first afforded the opportunity to study a
more advanced mathematics curriculum, their achievement
equaled and in some cases exceeded that of boys.

In order to understand the relation between girls'
mathematical ability and their pursuit of a career in
physics or engineering, it is important to consider self
selection, the process by which girls choose one career path
over another. Noting the absence of girls in such
mathematical career fields as physics or engineering, some
researchers have concluded that girls do not perceive
mathematics to be a possible or desirable field of endeavor.
However, by examining the career choices of young Wisconsin
women who became secondary school teachers, this study

173
demonstrates that women have in fact selected mathematics as a subject of study when it has been uncoupled from such traditionally male careers as engineering or physics and associated with the more conventionally female role of teaching. Thus, the relative absence of women in the mathematical sciences almost certainly has less to do with the underlying mathematics of such fields than with other social and cultural factors, several of which are considered in the following chapters.

In an attempt to explain the absence of women in the mathematical sciences, it has been surmised that girls turned to the non-mathematical science of natural history because they did not receive advanced training in mathematics. However, this hypothesis cannot be supported by historical evidence. As demonstrated in the previous chapter, the courses of study and schoolbooks of girls' secondary schools indicate that the natural philosophy and astronomy textbooks available to them included increasing amounts of mathematics after the 1840s. After mid-century, the mathematical complexity of the most advanced texts used in girls' schools did not differ from those used in boys' schools. And although natural history did increase in girls' schools from 1840 through 1880, this increase was not accompanied by a corresponding decline in natural philosophy, or physics.77 As we shall see in the following chapter, the turn to natural history occurred precisely at the time that the level of mathematics offered girls in
their secondary schools compared favorably with that offered boys.

Notes


(7) Thomas Woody, A History of Women's Education in the United States, 1, 138; 140.


(9) Quoted in Thomas Woody, A History of Women's Education, 1, 221.


(13) Almira Hart Lincoln Phelps, Lectures to Young Ladies (Boston: Carter, Hendee and Co., 1833), 242-43.


(16) The term "conceptual science" is used here to identify the non-mathematical sciences commonly offered girls in their secondary schools before 1840.

(17) This is the argument advanced by Emma Willard in her Address to the Public, (Particularly) to the Members of the Legislature of New York, Proposing a Plan for Improving Female Education (Albany: I. W. Clark, 1819), 4ff.

(18) Timothy Dwight of Yale, director of Greenfield Hill Academy in Connecticut, aroused a great deal of public indignation when he allowed girls to study the same mathematics courses that were offered to boys: algebra, geometry, spherics, and calculus. See Cohen, A Calculating People, 143.


(21) Ibid., 147n.

(22) Ibid.


(24) Fowler, "Educational Services of Mrs. Emma Willard," 146.

Phelps became known as an educator around 1830, when she assumed the duties of acting principal at Troy during her sister's visit to Europe. She later took charge of a girls' school at West Chester Pennsylvania, and in 1841, assumed direction of Patapsco Female Institute at Ellicotts Mills, Maryland.


Quoted in Woody, A History of Women's Education, 1, 372.

"Bedford Female Academy," in Richmond Enquirer (Nov. 3, 1837).

(39) In the North Carolina sample, the following schools offered geometry to girls before 1825: Raleigh Academy, female department (1820); New Bern Academy, female department (1823); Hillsborough Female Seminary (1825). Hillsborough Female Seminary, which advertised algebra in its course of study in 1825, was the only institution to offer girls algebra before 1830. See *North Carolina Schools and Academies, 1790-1840* ed. Charles L. Coon (Raleigh: Edwards and Broughton Printing Co., 1915), 458; 58; 300.

(40) None of the 42 girls' schools included in the North Carolina sample included navigation and surveying in their advertised courses of study. Mulhem did not include these subjects in his tables of subjects offered in secondary girls' schools.


(42) Mulhem does not provide data for the subjects of mathematics, navigation, or surveying in the female schools in his sample.


(46) Two boys' schools, Phillips and New South, are not included in this sample because there exists little information about the math instruction offered in these schools. About Phillips School, the Boston school committee stated only that the school had been established the previous year and that the first class in arithmetic had "gone nearly through the third part." About New South School, the committee stated only that it had been established a short time. See Caldwell and Courtis, *Then and Now*, 225-6.

(47) Quoted in "Girls in the Public Schools of Boston," in *The American Journal of Education*, 13 (1863): 248. This article includes lengthy extracts from the Boston school committee reports.

(48) Ibid., 248-9.
(49) Ibid., 247.


(51) Annual Report of the School Committee of the City of Boston, 1857, 261.

(52) Ibid.


(54) Quoted in Annual Report of the State Superintendent of Public Instruction of the State of Wisconsin (Madison, Atwood and Rublee, 1858), WSHS, 157.


(59) Lucy Larcom, A New England Girlhood (Boston: Houghton,


(61) Ibid., 134.


(66) The data are drawn from the reports made by inspectors who visited Wisconsin High Schools. There is no indication that inspectors visited every class at each school, but they gave the subject of those classes they visited, along with teachers' names and brief evaluations of the teaching observed. I collected data at 4-year intervals.


(68) The Leland Stanford Junior University First Annual Register, 1891-1892 (Palo Alto, California: Stanford University, 1892), 105-6; Sixth Annual Register, 171-6; Eleventh Annual Register, Sixteenth Annual Register, 230-5; Twenty-first Annual Register, 217-21; Twenty-sixth Annual Register, 269-277; Thirty-first Annual Register, 321-329; Thirty-sixth Annual Register, 383-99.


(71) Data compiled from the University of California Register, 1907-8, 544-45. Women congregated in the College
of Natural Sciences. Of the 43 bachelor of science degrees awarded in 1908, 32 were awarded to women. The College of Letters awarded one Bachelor of Arts degree in mathematics that year, also to a woman (549-50); Data compiled from the University of California Register, 1911-12, 10-13; 18-19. See also the Fortieth Commencement of the University of Wisconsin, 1892, Wisconsin University Archives, through the Fiftieth Commencement of the University of Wisconsin, 1902. At Wisconsin, fewer than five bachelor degrees were awarded in mathematics in any one year.


(74) Quoted in Woody, A History of Women's Education 1, 115-6.


(77) See Chapter 2, table 4. During the period from 1830 to 1889, 77% of Pennsylvania schools offered botany, a marked increase over the earlier period, from 1750 to 1829, when only 14% offered the subject. Nevertheless, still more schools (88%) continued to offer natural philosophy during the later period.
Chapter 5
The Feminization of Natural History

Introduction

Although it had long been enthusiastically embraced as a hobby among male and female amateurs, natural history was slow to enter the curricula of American academies and seminaries. During the early nineteenth century, the science most frequently included in the courses of study of such schools was natural philosophy, closely followed by astronomy and chemistry. Although a general treatment of natural history topics could be found in most geography textbooks at this time, it was relatively unusual for a student to receive instruction in natural history as a separate subject.¹ During the middle decades of the century, however, this picture began to change. As this chapter will demonstrate, by the dawn of the twentieth century, natural history appeared to be the science most preferred among young women.

How can we account for the overwhelming preference among late-nineteenth-century girls for the subjects of natural history? To date, historians have explained this development as a result of the extra-curricular nature literature aimed at a female audience during the late eighteenth and early nineteenth centuries, on the influence of cultural beliefs linking women to nature, or on presumed deficiencies in girls' mathematics schooling.² As
demonstrated in the previous chapter, this last explanation is without foundation: girls' secondary-school mathematics preparation was comparable to that of boys after mid-century. What merit have the first two explanations? To what extent can the feminization of natural history be attributed to the influence of cultural stereotypes and the marketing of nature literature to a female audience?

In this chapter, I argue that middle- and upper-class women specifically targeted natural history as a subject compatible with women's sphere in order to stake out an arena in which they could effectively participate in science--initially as amateurs, and ultimately as professionals. The following discussion analyzes women's motives for selecting natural history over other subjects, the rhetoric women used to advance natural history among girls, and the long-range effects of promoting this subject over the other sciences.

Because they played an important role in promoting natural history as a feminine interest, natural history schoolbooks and nature literature written for a female audience are among the primary sources used in this study. Their authors were often women. What messages did they give their female readers about the appropriateness and limitations of women's scientific interests? In the following discussion, I consider several means by which cultural views of middle-class women's social roles appear to have both encouraged and structured the participation of
Motives for Turning to Natural History

Social developments in the American natural history tradition influenced women to select natural history as an area of potentially fruitful endeavor. More than any other science, the subject had long held a place in American society as a field open to amateurs and professionals alike.

Although it entered the curriculum relatively late as a school subject, American men and women had interested themselves in natural history since the Revolutionary period. Inside the schoolroom, geography textbooks brought an array of natural history topics to American children just after the Revolutionary War; outside the schoolroom, other vehicles for the popular dissemination of natural history included magazines, public lectures, and a growing cadre of nature books directed to a general audience.

A variety of media conveyed the appeal of natural history to early nineteenth-century Americans, including nature books, lyceums, and magazines. A developing genre of American nature writing brought general topics in natural history and some scientific nomenclature to a general audience. American nature writers typically described their locations in scientific or near-scientific terms. These narrators of nature often were, or wanted to be, amateur scientists: botanists, ornithologists, or geologists. For example, Thoreau took care to identify plants and animals
with the appropriate Latin name when he knew it:

I have seen at one time lying on the ice pickerel...peppered on the sides with small dark brown or black spots, intermixed with a few faint blood-red ones, very much like a trout. The specific name reticulatus would not apply to this; it should be guttatus rather.³

The tradition of turning toward natural history to compose and delineate the physical environment was continued through the century by such later writers as John Burroughs and John Muir, who frequently used scientific nomenclature to identify local flora and fauna.⁴

Both men and women learned to appreciate natural history through lyceum lectures in their towns and villages. The lyceum movement began in the 1820s under the leadership of Josiah Holbrook a graduate of Yale College. In 1826 Holbrook outlined his plan for a lyceum in a paper printed in the new American Journal of Education; in 1828 he organized the American "Lyceum or Society for the Improvement of Schools and Diffusion of Useful Knowledge. In 1831 a National Lyceum was organized. In 1834 there were already nearly 3,000 lyceums in the United States; in 1839 Horace Mann counted 137 in Massachusetts alone.⁵

The lyceum movement brought lecturers to remote villages across the nation. "Where is science now?" asked William Ellery Channing, for many years a prominent Unitarian clergyman of Boston. "Locked up in a few colleges, or royal societies, or inaccessible volumes?...No,
science, has now left her retreats:

...There are parts of our country in which lyceums spring up in almost every village for the purpose of mutual aid in the study of natural science.⁶

Magazines catering to children and families often included articles and stories on natural history subjects. Such widely circulated periodicals as the Youth's Companion regularly offered information about natural history to its subscribers. Gardening articles reprinted from the British magazine Child's Companion also found their way into the pages of this, America's most popular family magazine.⁷ According to Elizabeth Keeney, autobiographical and biographical accounts suggest that "botanizing" was becoming a popular pastime among middle-class American children by mid-century. Children frequently wrote letters about botanizing. Typical of such letters was a missive written in 1847 to the magazine, Youth's Cabinet, by female students in Lewisberry, Pennsylvania, who wrote to request more botany: "We like it very well...but we think we would like it still better if you would give us more of Natural History and Botany in its pages."⁸

Unlike physics or astronomy, which retained a somewhat elitist character, its advocates argued that natural history was profoundly democratic. In contrast to the amateur physicist or astronomer, the amateur naturalist's requirements were relatively few and inexpensive. A field guide, collection box, magnifying glass and a few odd
bottles were sufficient to equip the collector. Thoreau collected specimens in his hat. In spite of the rhetoric of egalitarianism, however, natural history's popular appeal was largely directed to members of the middle and upper classes. Although the scientist Louis Agassiz proclaimed that his work would "be read by operatives, by fishermen, by farmers, quite as extensively as by the students of our colleges," there is little evidence that the hobbies of natural history were ever extensively embraced by members of the working or farming classes. Letters about natural history topics published in children's magazines were often from children whose families were sufficiently wealthy to have vacationed in Europe.

Much of the more literate American public's fascination with science just after mid-century was fueled by exciting and controversial theoretical developments in the field of natural history. The debates over the evolution of species, popularized in newspapers and magazines and carried to a general audience from pulpits across the country, soon made the names of Charles Darwin, Herbert Spencer, and Thomas Huxley familiar to the American on the street. For naturalists, the atmosphere of the period was charged with excitement. "One who was not reared in that epoch cannot comprehend the ardor of it," wrote Cornell University's Liberty Hyde Bailey many years afterward. It was, he recalled, "like a religious revival, when not only were critical subjects explained but the human spirit was
liberated. It was an era of cordial and stimulating philosophies."13

While the popularization of natural history played an important role in arousing middle- and upper-class women's interest in the subject, another key factor was the presumed compatibility between this science and the cultural doctrine of women's sphere. Even before natural history textbooks had appeared in great numbers in American schoolrooms, some schoolbook authors had encouraged middle-class American girls to take up an interest in natural history because the subject was seen as particularly appealing to women. For example, Joseph Richardson's 1811 reader, The Young Ladies' Selection of Elegant Extracts, recommended the study of natural history as affording "a delightful study."14

While schoolbook authors exhorted girls to study natural history and other scientific subjects, they were also careful to point out the limits of a girl's appropriate participation in science. Both male and female writers invoked the doctrine of women's sphere to demarcate the limits of women's scientific interests. The Young Ladies' Selection taught its readers that "The sphere of the fair sex [is] marked out by the Creator," and that "woman [was] designed as a helper" to man. The same reader cautioned young girls that while they might take up the study of natural history, "it is not however expected that you should have a systematic idea of every vegetable, animal, or
insect..."\textsuperscript{15}

The model of women's sphere was created by generations of men and women who argued that the ideal woman was a devoted mother and virtuous wife. The proper site of her activities was the home, where she provided for the physical, mental, and moral well-being of her family.\textsuperscript{16} Young girls were taught to walk a thin line between attaining intellectual rigor and maintaining feminine modesty. On the one hand, the influential author Hannah More recommended a vigorous course of study for girls:

I would recommend a predominance of those more sober studies...which will teach her to elicit truth; which will lead her to be intent upon realities; which will give precision to her ideas; will make an exact mind..."\textsuperscript{17}

On the other hand, and in the same text, another author ominously cautioned girls to "be even cautious of displaying your good sense," and to keep any learning "a profound secret," especially from men, who "generally look with a jealous and malignant eye on a woman of great parts and a cultivated understanding."\textsuperscript{18}

While both sexes read the natural history literature published in popular magazines and general readers, the rise of natural history subjects in middle- and upper-class girls' schools can be attributed in part to the development of natural history schoolbooks aimed primarily at a female audience. Among the most influential were those of Almira Hart Lincoln Phelps, who authored textbooks in a number of
fields, including botany and geology. Phelps had studied botany under Amos Eaton, the director of the Rensselaer Institute and an ardent promoter of science. Later an instructor at Troy Female Seminary, where her sister Emma Hart Willard was principal, Lincoln Phelps taught botany to a class of about forty pupils. Finding "the want of a suitable book for beginners," she published her own Lectures on Botany in 1829.

Some of the rhetoric used by Lincoln Phelps to advance botany could have been addressed to either a male or female audience; other statements were clearly gender specific. Her portrayal of botany as an admirable vehicle for attaining a variety of pedagogical goals, including the development of moral character, physical strength, observation skills, logical thinking, and orderly habits, probably would have appealed to the parents of both boys and girls. So would her emphasis of botany's utilitarian value. Yet she often used the restrictive rhetoric associated with women's sphere to advance natural history among her female readership. She argued that the beauty and delicacy of flowering plants made botany "peculiarly adapted to females," and that it "provided a source of refined enjoyment." Additionally, she assured her readers that the vegetable world was thought to offer many evidences of the Creator's design, leading "to greater love and reverence for the Deity."

Addressing her female audience, Lincoln Phelps
characterized botany as a subject more suited to the intellectual capacities of women than was astronomy. While women's "feeble minds" might seem overwhelmed by the contemplation of the distant and immense heavenly bodies, the plant world offered a more modest field of inquiry, one "which may be explored with the most pure and delightful emotions."

[In the vegetable world] the Almighty seems to manifest himself to us with less of that dazzling sublimity which it is almost painful to behold in His more magnificent creations; and it might almost appear, that accommodating the vegetable world to our capacities, He had especially designed it for our investigation and amusement.21

By including several women in her overview of the history of botany, Lincoln Phelps stressed the appropriateness and naturalness of women's botanical interests. She pointed to France, where "Josephine, the first wife of Napoleon, was distinguished for her fondness for this study," along with "other ladies of distinction, stimulated by her example." In England, "Mrs. Wakefield, and the industrious and talented Mrs. Marcet...have distinguished themselves as the authors of useful treatises on Botany."22 Exhorting her readers to popularize natural history by making it fashionable, she encouraged ladies to "frequently exhibit specimens of their own scientific taste" in their parlors.23

While highlighting the congruity of natural history and women's sphere, Lincoln Phelps was occasionally quite
explicit about the limits of girls' appropriate participation in botany. Existing social mores required girls and boys to develop different approaches to botanizing. Although she recommended frequent botanical excursions to her readers so that they might experience the "pleasure from the science, by seeing the flowers in their own homes," she cautioned that some areas of nature were inaccessible to girls because of their sex:

To the hardier sex, who can climb mountains, and penetrate marshes, many strange and interesting plants will present themselves, which cannot be found except in their peculiar situations; of these you must be content to obtain specimens, without seeing them in their native wilds.

At Emma Hart Willard's Troy Female Seminary, young ladies neither ventured deep into the woods nor scaled steep banks in search of botanical specimens; rather, a pattern developed in which boys collected for girls. According to Lincoln Phelps, "The young gentlemen students of the Rensselaer School were chivalric and indefatigable in their efforts to produce specimens for the ladies' herbaria and so Botany became the fashion of the day." Many students from Troy, Amos Eaton's nearby Rensselaer Institute, and from Lincoln Phelps' Patapsco Female Institute in Maryland became teachers, spreading the gospel of botanizing across the country. So popular was botany among middle- and upper-class American women, and so common was the belief that mothers should teach it to their
children, that magazine illustrations spoofing the trend appeared near the end of the century (see Plate 5.)

Plate 5

"First Class in Botany---Please Rise!"
In an advertisement to the 1840 edition of Lincoln Phelps's *Botany for Beginners*, designed for use in common schools, the publisher noted that since the publication of her text, botany had been introduced as a regular branch of instruction "not only into Colleges and Female Institutions of the first rank, but into many schools of a more humble character."²⁹

In North Carolina, the compendium subject of natural history and its related subjects of botany, mineralogy, and geology entered the curriculum of middle-class girls' schools during the second and third decades of the nineteenth century. At the same time, these topics attained a visible, although proportionally smaller presence in boys' schools as well, as shown in Table 1.

<table>
<thead>
<tr>
<th>Years</th>
<th>Natural Philos.</th>
<th>Astronomy</th>
<th>Chemistry</th>
<th>Geology</th>
<th>Botany</th>
<th>History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female Schools</td>
<td>28%</td>
<td>33%</td>
<td>11%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Male Schools</td>
<td>35%</td>
<td>23%</td>
<td>4%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Female Schools</td>
<td>73%</td>
<td>62%</td>
<td>62%</td>
<td>9%</td>
<td>38%</td>
<td>9%</td>
</tr>
<tr>
<td>Male Schools</td>
<td>43%</td>
<td>30%</td>
<td>20%</td>
<td>2%</td>
<td>4%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: Data compiled from newspaper advertisements included in *North Carolina Schools and Academies 1790-1840: A Documentary History*, ed. Charles L. Coon.³⁰
A similar trend occurred in Pennsylvania. School catalogs from girls' and coeducational schools in Pennsylvania reveal that the subjects of botany, geology, and natural history were more often offered in girls' schools, although all three subjects also increased in the curriculum of boys' schools during the nineteenth century (see Table 2.)

Table 2

Percentage of Pennsylvania Female and Coeducational Schools Offering Botany, Geology, and Natural History, 1750-1819 and 1830-1889

<table>
<thead>
<tr>
<th>Years</th>
<th>Botany</th>
<th>Geology</th>
<th>Natural History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1750-1819</td>
<td>14%</td>
<td>0</td>
<td>11%</td>
</tr>
<tr>
<td>Coed</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1830-1889</td>
<td>77%</td>
<td>33%</td>
<td>29%</td>
</tr>
<tr>
<td>Coed</td>
<td>33%</td>
<td>28%</td>
<td>12%</td>
</tr>
</tbody>
</table>

Source: Mulhern, A History of Secondary Education in Pennsylvania, 328-29; 428-29; 542-43.

The natural history subjects of botany and geology evidenced an astonishing growth during the nineteenth century. In New York secondary schools from 1830 to 1870, geology experienced a seventeen-fold and botany an almost five-fold increase. By 1870, roughly equal numbers of New York schools offered botany as offered astronomy or chemistry. Nevertheless, these subjects still lagged behind natural philosophy in many schools (see Table 3).
By the end of the century, the science of botany appeared to have become a girls' subject in both American and British secondary schools. In a 1902 report, British educators noted that botany was taught "particularly well in those [schools] for girls." In 1907, an American school superintendent expressed concern over the science courses in his city's secondary schools because, not only were enrollments low, but most of the students taking the botany course were girls.32

Besides botany, women nature writers popularized several other natural history subjects as suitable for girls. Entomology, the study of insects, was characterized by women writers as suitable for females. Lincoln Phelps noted that "the study of spiders is one of the most elegant

Table 3
Percentage of New York Secondary Schools Offering Various Sciences, 1830-1870

<table>
<thead>
<tr>
<th>Year</th>
<th>Natural Philosophy</th>
<th>Astronomy</th>
<th>Chemistry</th>
<th>Geology</th>
<th>Botany</th>
</tr>
</thead>
<tbody>
<tr>
<td>1830</td>
<td>77</td>
<td>40</td>
<td>50</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>1835</td>
<td>100</td>
<td>83</td>
<td>95</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>1840</td>
<td>100</td>
<td>87</td>
<td>93</td>
<td>28</td>
<td>74</td>
</tr>
<tr>
<td>1845</td>
<td>96</td>
<td>84</td>
<td>90</td>
<td>35</td>
<td>74</td>
</tr>
<tr>
<td>1850</td>
<td>95</td>
<td>91</td>
<td>87</td>
<td>31</td>
<td>70</td>
</tr>
<tr>
<td>1855</td>
<td>96</td>
<td>93</td>
<td>79</td>
<td>38</td>
<td>82</td>
</tr>
<tr>
<td>1860</td>
<td>92</td>
<td>77</td>
<td>79</td>
<td>41</td>
<td>73</td>
</tr>
<tr>
<td>1865</td>
<td>95</td>
<td>67</td>
<td>70</td>
<td>42</td>
<td>70</td>
</tr>
<tr>
<td>1870</td>
<td>92</td>
<td>65</td>
<td>67</td>
<td>34</td>
<td>68</td>
</tr>
</tbody>
</table>

and delightful of all pursuits." In 1844, Mary Townsend, sister of the naturalist John Kirk Townsend, published *Life in the Insect World: or, Conversations Upon Insects Between an Aunt and her Nieces*, in which the conversational format borrowed heavily from the earlier texts published by the British writer Jane Marcet. Writing in 1853, the Swedish author Fredrika Bremer heartily approved of both Townsend's science and her natural theology:

The turn for minute detail, acute perception of the lesser world, which is peculiar to woman..., together with a poetic feeling which allies it to the spiritual...these are all natural endowments which seem singularly to befit woman for that portion of science, and should in their pursuit and their application tend to make the searching soil richer in its daily life.

Later women authors who popularized entomology included Anna Botsford Comstock (1864-1930), natural history illustrator and teacher of nature study at Cornell University, who published *Ways of the Six-Footed* in 1903.

Unlike botany and entomology, zoology and ornithology were viewed as men's subjects until relatively late in the nineteenth century. Until after mid-century, ornithology required the shooting of live birds for study; few middle-class ladies would have felt it proper to venture forth into the fields with a shotgun in search of bird specimens. Similarly, the study of zoology entailed the dissection of animal specimens. In *Familiar Lectures on Botany*, Lincoln Phelps favorably contrasted the delicate study of plants with the potentially more grisly study of animals, noting
that while plants could be easily dissected, the dissection of animals could not be undertaken "without painful emotions."\textsuperscript{36}

Although young ladies might make collections of such geological specimens as fossils or minerals, they were not expected to go on geological surveys or dig geological specimens out of the earth themselves. Additionally, geology's association with the mining industry may have made it an unsuitable subject for girls. Even near the end of the nineteenth century, and for several decades into the twentieth, geology remained a traditionally male subject, unlike such other subjects as botany, entomology, chemistry, physics, or physiology. For example, at Stanford University during its first quarter century, bachelor of arts degrees were conferred on females in every scientific subject except geology.\textsuperscript{37} (See Table 4.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Entomology</th>
<th>Botany</th>
<th>Physiology</th>
<th>Zoology</th>
<th>Physics</th>
<th>Geology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1892</td>
<td>0%</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
<td>--</td>
<td>0%</td>
</tr>
<tr>
<td>1897</td>
<td>0%</td>
<td>100%</td>
<td>13%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>1902</td>
<td>--</td>
<td>--</td>
<td>40%</td>
<td>40%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>1907</td>
<td>67%</td>
<td>100%</td>
<td>10%</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>1912</td>
<td>25%</td>
<td>67%</td>
<td>20%</td>
<td>75%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>1917</td>
<td>33%</td>
<td>50%</td>
<td>14%</td>
<td>33%</td>
<td>50%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Source: Data compiled from the 1st, 6th, 11th, 16th, 21st, and 26th volumes of \textit{The Leland Stanford Junior University Annual Register} (Palo Alto, California: University Press).
Girls learned from their schoolbooks that there were limits to the extent of their participation in science. "Females, in particular," wrote Lincoln Phelps, are not expected to enter into the recesses of the temple of science."38 Middle-class girls studied science to attain mental discipline, avoid frivolity, and gain a patina of gentility. As popularizers of science, they served the new republic by making science fashionable; by bringing it into their parlors, they carried science into the very heart of civilized American life.39

The Impact of Darwin's Evolutionary Theory on Field Studies

Although the publication of Darwin's The Origin of Species in 1859 may have had little immediate impact on the popular enthusiasms of natural history collectors, it did shift the arena of interest for amateurs and professionals alike from the individual specimen to the living organism within its environment. In the concluding paragraph of The Origin, Darwin's depiction of an "entangled bank" illustrated the naturalist's new sphere of investigation: "clothed with many plants of many kinds, with birds, singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth...[all] dependent upon each other in so complex a manner."40

Restricted by social mores from killing animals, women benefited from the shift to field studies spurred by Darwin's revolutionary theory. As the historian Lynn Barber
points out, the new generation of naturalists turned its attention to the field, previously the disdained arena of amateurs. Followers of Darwin wanted to study living organisms rather than dead ones, and they wanted to study them in their natural habitats.41

Advances in technology also assisted study in the field. The first prism binoculars were patented in 1859, and in the next decades, the invention of film, flashlight and telephoto lens contributed enormously to the study of living birds.42 Popular bird books such as Florence A. Merriam's Birds Through an Opera Glass and Olive Thorne Miller's The Children's Book of Birds stressed the importance of bird-watching. Such authors argued that the environment of the living creature, not the laboratory, was the proper site for study. As Olive Thorne Miller advised American children, "to see how birds live is much more interesting than to look at dead ones."43

From a profusion of nature books in the second half of the nineteenth century, girls learned repeatedly of the benefits of field studies. For example, from Elizabeth Cady Agassiz, they learned how to study at the seashore such living organisms as sea-anemones, corals, jellyfish, and sea-urchins. Agassiz instructed her readers to capture living specimens for observation. Wife of the Harvard scientist Louis Agassiz, Elizabeth Agassiz published in 1879 a natural history of marine flora and fauna in a book addressed to a female readership. Using the conversational
format made famous by Jane Marcet, Agassiz wrote her text in the form of a letter from Aunt Lizzie to her two nieces, Lisa and Connie.44

Back-to-Nature

The historian Peter Schmitt has characterized the second half of the nineteenth century as a period in which a "back to nature" movement emerged among urban Americans. He depicts the trend as a "definite call to nature." With it came a new interest in sports, landscape gardening, voyages of discovery, conservation, nature poetry, nature study, magazines of outdoor life, and camping. During this time, women played an important role in developing local parks and gardens in urban communities, in popularizing the need for conserving natural resources, and in bringing nature study to students in common schools.45

A likely early role model for the attention that middle- and upper-class American women gave to rural nature was Susan Fenimore Cooper, daughter of the novelist, James Fenimore Cooper. Susan Cooper based her novel, Rural Hours, on her daily nature journal, which became an overnight success when it was published in 1850.46 According to the historian Marcia Myers Bonta, with the publication of Rural Hours, Susan Fenimore Cooper launched a tradition of observational nature writing taken up by later generations of American women.

Although hers is a name, unlike that of John Muir or Theodore Roosevelt--less well known in conservation circles,
Susan Fenimore Cooper was one of the earliest American writers to draw attention to the destruction of the environment. In *Rural Hours*, Americans learned not only of the seasonal changes in nature, but of the destruction of certain plant and animal species. "All kinds of black-birds are rare here," Cooper noted on April 27, 1848; "they are said to have been very numerous indeed at the settlement of the country, but have very much diminished in numbers of late years."47 She wrote despairingly, too, about the wanton obliteration of local forests:

> It has been calculated that 60,000 acres of pine woods are cut every year in our own State alone; and at this rate, it is said that in twenty years, or about 1870, these trees will have disappeared from our part of the country.48

As they emphasized the importance of studying live organisms in their natural environments, later nineteenth-century women naturalists frequently argued for the protection of living things. According to Anna Comstock of Cornell University, "The nature-study teacher, if she does her work well, is a sure aid in inculcating a respect for the rights of all living beings to their own lives." Comstock claimed that, at Cornell, "those students who turn aside so as not to crush the ant, caterpillar or cricket on the pavement are almost invariably those that are studying entomology." What Comstock did not mention is that those Cornell students interested in entomology were often women. Cornell's Jugatae Club, an entomological club comprised of
both faculty and student members, included many women, as shown in a photograph taken in 1901 (See Plate 6.)

Plate 6
Cornell University's Jugatae Club, 1902
(Courtesy of Division of Rare and Manuscript Collections, Carl A. Kroch Library, Cornell University)

Near the end of the century, a prevalent stereotype portrayed boys as the destroyers of wildlife and girls as its preservers. Leaflets disseminated by the early agricultural experiment stations often criticized the depredations of local fauna by American boys through egg
stealing and shooting. Among the leaflets produced by Purdue University was "Spring Birds," by Mrs. Jeanette D. Ruby, who opened her article with the question, "I wonder why every boy that can borrow a gun goes out into the woods and tries to kill birds."

School readers published during the last decade of the century often included moralistic nature stories in which boys convert from destroying nature to protecting it. For example, in a typical story entitled, "In the Rabbit's Place," Frank, a boy fond of chasing and terrorizing his uncle's rabbits, has a dream in which he is transformed into a rabbit himself. As a rabbit, Frank is chased by a menacing boy who runs after him "pell-mell, shouting and shaking a cane." After he awakes from this frightening dream, Frank never chases a rabbit again.50

The contrasting image of girls as protectors of wildlife can also be found in school readers.51 An American schoolbook published in 1883 includes a story about the demise of a boys' woodchuck society when it is infiltrated by girls. In the story, the girls of a certain school belong to a tatting club and the boys to a woodchuck society. Bored with tatting and curious about the boys' activities, the girls ask for admission to the society. After the girls promise to learn woodchuck lore and wear veils to avoid freckles, the boys allow them to join. At the end of the hunt, however, the girls find it impossible to face killing and skinning the hapless woodchuck. To the
leader of the girls, the chairman of the woodchuck society
complains, "We've let you into the Society, and you
wouldn't have the woodchuck killed. You'll never have the
woodchucks killed, and then what is the use in chasing
woodchucks?" In response, the leader of the girls
immediately makes a motion to unite the woodchuck and
tatting associations into a picnic club. After she
announces that lemonade and nuts will be served at the
picnic, the motion is seconded and carried by the approving
girls and not unwilling boys. Thus, without deliberation or
debate, the boys' woodchuck society comes to an end in that
school forever.52

Authors of children's nature schoolbooks published
during the last decade of the nineteenth century frequently
highlighted the necessity of studying nature in order to
better protect it. For example, a nature reader published
in 1896 tells the story of a boy who wonders about the brown
and yellow powder he finds on his hands after catching a
butterfly. His teacher, Miss Allen, gives him a dead
butterfly's wing to examine under the microscope. When the
boy discovers that the powder forms a part of the insect's
wing structure, Miss Allen responds, "I am glad you can see
this; for now I am sure you will always be careful in
handling the butterflies."53

In their socially accepted role as nature's protectors,
American girls found an additional rationale to study such
sciences as botany, entomology, and the field-based subjects
of ornithology and zoology. On the one hand, some level of scientific expertise in such studies was viewed as an elegant accomplishment; on the other hand, advocacy for the preservation of threatened species fit well with the increased awareness of conservation and the nostalgic back-to-nature movement sweeping middle-class America during the second half of the century.

**Employment Opportunities in Natural History**

By 1871, Americans' view of women's proper sphere had expanded to include several career paths outside the home. Of course, the domestic doctrine of women's proper sphere was largely articulated by and directed to members of the middle and upper classes. For those many women from the lower classes who found employment outside the home, the doctrine was a myth. In 1870, women constituted fifteen percent of the nation's workforce, working not only in such stereotypically female occupations as laundresses, domestic servants, and seamstresses, but in a great variety of other occupations, including box-factory operatives, cotton-mill operatives, and book-binders. In discussing employment opportunities for women from the higher classes, one author claimed that while "American sentiment revolts against her employment as a common farm laborer, the lighter work of gardening, with ornamental horticulture, seems perfectly adapted to [women]." Ironically, at the time the report was written, thirteen percent of all agricultural laborers in the country were female.
In their search for forms of employment compatible with their higher social status, elite women turned to the fields of natural history and agriculture. In 1871, the United States Commissioner of Education published a report entitled the "Progress of Education for Women," which listed the following occupations as particularly suitable for females: illustration, nursing and medical practice, horticulture, and schoolteaching. No one doubted that middle- and upper-class women would find the science involved in the study of horticulture appealing. "For women of leisure," claimed the author of the report, "the studies connected with the course--drawing, botany, chemistry, and entomology--are interesting..." After all, such subjects had long been thought highly appropriate for young ladies.57

The growing professions associated with natural history afforded women a greater variety of employment opportunities than were available in physics or astronomy. Natural history museums and departments in colleges and universities required the services of zoological and botanical assistants to catalog and maintain their burgeoning collections; scientists required illustrators to prepare drawings for exhibits and manuscripts. In 1873, the members of the New England Women's Club expressed gratitude to Harvard scientist Louis Agassiz for employing women as assistants in his museum. They also noted approvingly that Harvard University had opened the doors of its agricultural school
to women.\textsuperscript{58}

One particularly useful source for understanding the newer views of women's sphere promoted among the middle and upper classes is the report of the Women's Centennial Executive Committee. The Committee was responsible for organizing an exhibition of women's work for the Centennial Exhibition to be held in Philadelphia in 1876. In answering the question, "What can women do that is worthy of being displayed at the Exposition?" members of the Centennial Executive Committee listed a variety of accomplishments drawn from the fields of natural history and agriculture.

Women of the Centennial Executive Committee expressed enthusiasm about scientific illustration as a career for women. "What more interesting specimen of women's work could be exhibited, than a set of Mrs. Wormley's microscopic drawings, illustrated by herself?" The possibility of obtaining a livelihood from illustration was intriguing, since there seemed to be no limit to the work, "at profitable prices," that women might do as illustrators.\textsuperscript{59}

Reflecting women's culturally accepted role as naturalist and horticulturist, women of the Centennial Committee asked for contributions from the fields of natural history:

\ldots many of our women might make contributions; for instance, collections of the different grains, grasses, fruits, vegetables, wild flowers, ferns, mosses...geological specimens, fossils, insects, butterflies, or stuffed birds...arranged in compact form and with skill and taste, would be valuable.\textsuperscript{60}
During the next several decades, growing numbers of women found some employment as botanical assistants and illustrators, first in herbaria and museums, and later in the newly formed agricultural experiment stations.61 According to historian of science Margaret Rossiter, the federal Bureau of Plant Industry regularly hired women as assistants starting in 1887.62 Growing numbers of women also seem to have found work in the last decades of the century in the private sector as gardeners, nursery workers, and florists (see Table 5) although, as in all forms of employment during this period and later, the wages paid to women were consistently lower than those paid to men.63.

Women sought employment as natural history teachers when the opportunity arose, though sometimes with limited success. The 1870s was a period in which intensified discussions of the importance of scientific knowledge led

<table>
<thead>
<tr>
<th>Date</th>
<th>Gardeners/nursery workers</th>
<th>Florists</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>1%</td>
<td>4%</td>
</tr>
<tr>
<td>1880</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>1890</td>
<td>8%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Source: Data for the years 1870 and 1880 compiled from Compendium of the Ninth Census: 1870, 604 and Compendium of the Tenth Census: 1880 Part 2, 1368. Data from 1890 compiled from Compendium of the Eleventh Census: 1890, Part 3, 598-599.
educators in several areas to attempt to introduce more science courses at both the secondary and primary levels in their public schools. In 1872, the state of Illinois took the step of certifying some of its teachers to teach the natural sciences in its public schools. In order to be certified, candidates had to pass an examination. Equal numbers of male and female teachers took the examination, and equal numbers of males and females successfully passed it. Nevertheless, perhaps taken aback by the numbers of women qualified to teach natural sciences in its schools, Illinois issued certificates to only roughly half as many females as males (see Table 6).

Women who selected science teaching as a career more often chose to specialize in the subjects of natural history than in physics. In the early twentieth century, many high schools created biology courses to replace the compendium subject of natural history and to offer instruction in the

| Table 6 |
|-----------------|-----------------|-----------------|
| **Results of the Illinois Examination and Certification in Natural Sciences, 1872** |
| **Number Examined** | **Number Successful** | **Number Certified** |
| Males | 1,989 | 1,557 | 1,018 |
| Females | 1,984 | 1,557 | 566 |

Source: Data compiled from the Report of the Commissioner of Education for the Year 1872, 75.
previously separate subjects of botany and zoology. In Wisconsin high schools, teachers of biology were more often female, whereas teachers of physics were predominantly male (see Table 7).

Table 7
Percentage of Male and Female Wisconsin High School Science Teachers, 1915-1928

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1915-16</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>1919-20</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>1923-24</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>1927-28</td>
<td>46%</td>
<td>54%</td>
</tr>
<tr>
<td>Physics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1915-16</td>
<td>97%</td>
<td>3%</td>
</tr>
<tr>
<td>1919-20</td>
<td>93%</td>
<td>7%</td>
</tr>
<tr>
<td>1923-24</td>
<td>100%</td>
<td>0</td>
</tr>
<tr>
<td>1927-28</td>
<td>92%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Source: Data compiled from Department of Public Instruction Office of the State Superintendent High School Inspection Reports [Wisconsin], boxes 1-4, Wisconsin State Historical Society

Why did young women choose biology over physics? By the early twentieth century, physics had lost its earlier connection with the cultural doctrine of woman's sphere. At first appreciated for its ability to promote mental discipline and natural theology, physics now conjured up images of factories and machines, harsh rationality, and cold, inanimate nature. An article published in Good Housekeeping informed readers that the intellectual woman made a poor mother. Instead, she should work in "the
laboratories, where matter has no feeling, and feeling is not needed to penetrate the mysteries of matter."67 Girls with an interest in science could consider themselves engaged in a suitably feminine pursuit by studying animate, organic nature.

The relatively few women who went on to become professional scientists more often chose to specialize in the subjects of natural history than in such subjects as physics, astronomy, or chemistry. A study of the baccalaureate origins of female scientists before 1920 reveals that more women received degrees in botany and zoology than in other scientific fields, including the nascent field of home economics. According to the historian Margaret Rossiter, who based her study on the first three editions of American Men of Science, 18 per cent of female scientists received degrees in botany, and 18 per cent received degrees in zoology. In contrast, degrees were awarded to only 8 percent in chemistry, 5 per cent in physics, and 4 per cent in astronomy.68

**Studying With Louis Agassiz**

In 1873, the Harvard professor of zoology, Louis Agassiz, set a highly publicized stamp of approval on the role of women as teachers of natural history. According to both contemporary accounts and the reports of later generations of science educators, this was a landmark year for natural history education.69 It was also a landmark
year for women interested in pursuing careers as natural history teachers. That summer, Agassiz invited 50 students to study at the newly-founded Anderson School of Natural History on Penikese Island, just off the coast of Massachusetts. The mission of this summer school was to train teachers:

The conditions for admission at the Anderson School of Natural History are simply these--it is intended especially for teachers--the preference being first for those who are already teachers of Nat. History and who want to make themselves familiar with the best methods of teaching from specimens,--next--to students intending to become teachers.

Instruction was free, the prestige of studying with Agassiz was enormous, and the faculty at the school included some of the best-known names in American natural history. As a result, the number of applicants far exceeded the 50 spaces available.

A phenomenal amount of publicity surrounded the opening of this school, and newspaper reporters crowded into the lecture hall and laboratory to report on every activity. This general brouhaha can only be understood in light of Agassiz's enormous popularity and influence. It was said of him, that on an occasion when he applied to the Massachusetts legislature for funds to support his Museum of Comparative Zoology at Harvard, one of the legislators publicly protested Agassiz's appearing in person, explaining, "I am not opposed to his institution, and am willing to give to it in reason; but if that man talks to us
for an hour we shall vote him whatever he asks for." It is hardly possible to overestimate the position Agassiz held in educational circles. So great was his prestige that the journal Education once offered as a gift to new subscribers the choice of a portrait of Horace Mann or Louis Agassiz.

When he opened the doors of the Anderson school, Agassiz surprised some of his colleagues by admitting eighteen women—roughly a third of the student body. A curious American public opened its newspapers to discover illustrations of women students, not only attending lectures and collecting specimens, but dissecting marine fauna (see Plate 7).

Several of Agassiz's male students were highly irritated at the presence of women among them. One or two days after the school opened, six students from Harvard and Amherst determined to show their disapproval. Sneaking in at night, they tossed into the women's quarters a huge doll baby made from a pillow and blanket. Furious, Agassiz expelled the pranksters the next day.

Why did Agassiz admit women to his school? In his opening address, he announced that the decision to admit women was "a question of no small moment...In my mind I had no hesitation from the start. There were those about us whose opinion I had to care for but did not know. I thought the best way was not to ask it, but to decide for myself." Curiously, this statement provides few clues as to the
reasons for his decision. It was known at the time that

Plate 7

1873 Newspaper Clipping Showing "Lady Students Dissecting"
(Courtesy, the Bancroft Library, the University of California at Berkeley)

Agassiz did not approve of coeducation in general. Given the eyewitness accounts published in contemporary newspapers, it is clear that he did not admit women with the aim of providing them with advanced training in science; he wished rather to impart a particular pedagogical method: studying from laboratory specimens and from the field.

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Agassiz himself described this objective in a letter to Burt Green Wilder of Cornell, inviting Wilder to participate in the school:

Among my plans is a course of practical instruction in Natural History...chiefly with the view of preparing our teachers to introduce natural history into our schools.80

The historian Joan Burstyn theorizes that, among other reasons, Agassiz invited female students because he needed the esteem and affection that only women could provide. In addition, she argues that women students were attractive because the fees they paid helped provide summer salaries for the men who taught them. However, in light of the fact that instruction was free at the Anderson School, this latter argument loses its credibility.81

It is likely that Agassiz admitted women because, mindful of their social roles as teachers and popularizers of science, he saw women as a yet untapped resource for natural history education. As shown above in Table 3, the natural history subjects of botany and geology lagged behind natural philosophy in the curriculum of many secondary schools during this period. Who better to spread the gospel of natural history than women, its traditional promoters? Whatever the reason, Louis Agassiz, arguably the most famous, certainly the most popular scientist in America, had made what some of his colleagues considered an inexcusably foolish gesture: he had flung open the doors of natural history education to women.

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Conclusion

The cultural construction of natural history as a subject fully compatible with the nineteenth-century doctrine of woman's sphere had enormous impact on the scientific interests of American girls. The majority of young women who sought to become professional scientists and science teachers selected the subjects of natural history to a far greater degree than physics or astronomy.

The publication of Almira Hart Lincoln Phelps's botany textbooks marked the beginnings of a feminized natural history curriculum in America. She and subsequent authors did not differentiate the scientific content from that commonly offered to boys; rather, they promoted an alternate scientific identity among girls. Their books portrayed girls and women as turning to nature, not in order to advance scientific knowledge, but to develop orderly habits of observation, to seek beauty and spiritual solace, to develop a patina of gentility, and to nurture and protect wildlife. Such authors traditionally cast women as popularizers of science rather than as creators of scientific knowledge.

By promoting natural history as a field of endeavor compatible with women's sphere, Phelps and others may have sought to assuage doubts the male scientific community may have had about girls' increasing pursuit of science. On the
one hand, these authors can be interpreted as limiting the range of women's roles in science; on the other hand, they can also be viewed as creating a non-controversial arena in which middle- and upper-class women could begin to participate (and even earn a living of sorts) in the scientific community.

Within a social and economic context in which increased employment opportunities in the fields of natural history and agriculture motivated growing numbers of young women to seek advanced study in such subjects as botany and zoology, the gender stereotypes encoded in natural history textbooks and other popular media proved to be very durable. As we shall see, they later also proved to be very controversial.

Earlier in the century, when middle-class daughters and sons were often instructed in single-sex secondary schools, the use of a feminized science curriculum assured the transmission of traditional, cultural roles to young girls who were presumably willing to assume subordinate roles in science. At the close of the century, however, most girls and boys studied in the same classrooms, and women filled most of the teaching positions in elementary and secondary coeducational schools. Mindful of the gender stereotypes that cast women as popularizers of science rather than as creators of scientific knowledge, these developments filled some male scientists and educators with apprehension.

For a time, however, issues of reform in natural
history received little attention from the general public. Louis Agassiz died in 1874, and his school was closed for lack of funds.82 For several years after his death, the debates over gender and education centered around such issues as suffrage and coeducation in colleges and universities, and the question of the role of women in science education drew scant notice. During this provident lull in the storm, a growing coalition of men and women naturalists, educators, and conservationists initiated a small educational reform that would later be called the nature study movement.

Notes

(1) See discussion in Chapter 2.


(3) *Walden and Other Writings of Henry David Thoreau*, ed. Brooks Atkinson (New York: Random House) 1937, 167. On several occasions Thoreau collected specimens of fish and reptiles for the scientist Louis Agassiz when the latter was at Harvard. From Agassiz's assistant Thoreau learned the names of various specimens. Agassiz also benefited nicely from the arrangement, receiving a variety of fauna he had never before seen, along with an occasional new species. See Thoreau to James Elliot Cabot May 3, 1847; Thoreau to Cabot, May 8, 1847; Thoreau to Cabot, June 1, 1847; Cabot to Thoreau, undated, in Walter Harding and Carl Bode (Eds.) *The Correspondence of Henry David Thoreau* (New York: New York University Press, 1958), 178-183.

characteristically turned toward the scientific disciplines to help them delineate and quantify their natural world. Fritzell argues that, as a result, a form of nature writing developed in America quite distinct from that in Great Britain.


(6) Quoted in Dirk Struik, *Yankee Science in the Making*, 215. It should be noted, however, that a broad selection of subjects was represented in lyceums by mid-century. To the lyceum in Salem, Massachusetts, came abolitionist speakers, such poets as Ralph Waldo Emerson and James Russell Lowell, Louis Agassiz and lesser known science enthusiasts, and a host of others lecturing on such topics as "Success," "Patriotism," and "The Effects of Physical Science Upon the Moral World." See the following journal entries of Charlotte Forten, *The Journals of Charlotte Forten Grimke* (New York: Oxford University Press, 1988): Nov. 8, 1854, Dec. 3, 1854, Dec. 6, 1854, Jan. 12, 1855, Jan. 24, 1855, Jan. 30, 1855, Feb. 7, 1855, March. 7, 1855, March 28, 1855, Dec. 25, 1855, Jan. 27, 1856, Feb. 11, 1856, Feb. 12, 1856.

(7) This conclusion is based on a survey of issues of *The Youth's Companion* published from 1850-1905. This magazine included something for every member of the family, from beginning readers to adults. Issues from 1850 to 1905 reveal a consistent American interest in the subjects of natural history, joined in the 1870s by increasing numbers of articles on recent inventions, technology, and agriculture.

(8) Quoted in Elizabeth Keeney, *The Botanizers*, 89-90.

(9) Keeney, *The Botanizers*.


(11) Evidence of the middle and upper class background of children writing to children's magazines can be found in the letters addressed to such magazines as *The Youth's Companion* and *St. Nicholas Magazine*. For example, see the letter from Emma W. Comfort in *St. Nicholas Magazine* (June 1882), 662.

(12) The magazine *Popular Science Monthly* opened its first issue with an article by Herbert Spencer, and regularly

(13) The quote is from an undated, unpublished manuscript in file 18, box 5, Liberty Hyde Bailey Papers (hereafter LHB Papers), Karl Kroch Library, Cornell University, New York.


(15) Ibid., 56; 138-9.


(17) Quoted in Richardson, The Young Ladies' Selection of Elegant Extracts, 68-9.

(18) Ibid., 45.

(19) Ibid., 14-5.


(21) Lincoln, Familiar Lectures (1832), 16.

(22) Ibid., 321.

(23) Lincoln, Familiar Lectures (1846), 31.

(24) Ibid., 30.

(25) Ibid.

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(27) Ibid., 58-59.


(30) The 1800-1819 data is derived from a sample of 18 girls' schools and 26 boys' schools; the 1820-1840 the data includes 45 girls' schools and 46 boys' schools.

(31) Mulhern's 1750-1829 data is derived from the catalogs of 36 girls' schools and 47 boys' schools; 1830-1889 the data is derived from the catalogs of 90 girls' schools and 116 coeducational schools.


(33) Lincoln, *Familiar Lectures* (1846), 200n.


(35) Bremer, *Homes of the New World*, 35.


(37) It is indicative of the paucity of women in geology that in her book, *Women in the Field: America's Pioneering Women Naturalists*, Marcia Myers Bonta includes no discussion of geology. Margaret Rossiter has noted that in both 1921 and 1938, women congregated in the branches of biology: agricultural sciences, biochemistry, botany, medical sciences, microbiology, nutrition, and zoology. She states that the field of geology remained among the smallest of fields for women. See Margaret Rossiter, *Women Scientists in America*, 137.

(38) Lincoln, *Familiar Lectures* (1846), 200.

(39) Ibid., 31. Lincoln Phelps exhorted her readers to popularize natural history by making it fashionable. To accomplish this, ladies should "frequently exhibit specimens of their own scientific taste" in their parlours.


(42) Ibid.


(44) Mrs. Agassiz, *A First Lesson in Natural History* (Boston: Ginn, Heath & Co., 1884 [1879]).


(47) Cooper, *Rural Hours*, 49.

(48) Ibid., 214.


(51) Boys rarely heed the strictures of girls in moralistic nature stories; they usually learn their lessons directly from nature. for example, in "The Wren's Nest," although a young girl urges a boy to leave the nest of a wren alone, the boy pays no attention until the wren itself attacks him about the head. In Annie Chase, *Friends of the fields* (Educational Publishing Co., 1898), 14-19.


(57) "Progress of Education for Women," in Report of the Commissioner of Education for the Year 1871 (Washington: Government Printing Office, 1872), 511-517. The quote is from page 515. The report adds that even the fields of industry, new opportunities were opening for women: as stenographers, telegraphers, and printers.


(60) Second Annual Report of the Women's Centennial Executive Committee, 34.


(62) Margaret Rossiter, Women Scientists in America: Struggles and Strategies to 1940 (Baltimore: Johns Hopkins University Press, 1982), 61. For a discussion of women's employment opportunities at the end of the nineteenth century, see Chapter 3 in Rossiter's book.


(64) First published in 1872, the magazine Popular Science Monthly was an important vehicle for advancing the importance of science education. See Popular Science Monthly, 1 (March, 1869): 23, where the editors state the pedagogical mission of the magazine. The first graded course of study in natural sciences seems to have been that created by Superintendent William T. Harris for the public schools of St. Louis. See the Report of the Superintendent of St. Louis, 1872-1873, 181-191, and Harris's course of study in the appendix of the same volume.

(65) In some schools, botany was still offered as a separate course. I have included teachers of botany in the sample of biology teachers.

(66) The data for the years 1915-16 is based on a randomly selected sample of 40 schools; data for 1919-20 is based on
an all-inclusive sample of 32 schools, 1923-24 an all-inclusive sample of 21 schools, and 1927-28 a randomly selected sample of 38 schools.


(68) Data compiled from Table 1.1 in Rossiter, Women Scientists in America, 11.

(69) "Minutes and Records, 1925," box 4, the American Nature Study Society Records, Cornell University Archives, New York. The minutes describe a paper presented by Anna Comstock of Cornell, tracing the development of the nature study movement to the "influence of the work of Agassiz." See also David Starr Jordan, Days of a Man, 1 (Yonkers-on-Hudson, New York: World Book, 1922), 119. According to Jordan, who later became president of Stanford University, of all the schools in the country, it was the Anderson School of Natural History that had the most extended influence on scientific teaching in America. Other contemporary accounts of the Anderson School include Frank Haak Lattin, Penikese: A Reminiscence by One of its Pupils (Albion, New York, 1895); H.B.C. Beedy, "Reminiscences of Penikese," in Education (Feb., 1893), 340; Henry Blake, "Personal Reminiscences of Professor Louis Agassiz," in Nature Study Review (March, 1923): 97-103. The most often quoted secondary source is still Edward Lurie, Louis Agassiz: A Life in Science (Chicago, 1960). A useful article for understanding the highly influential role of the school among women is Joan N. Burstyn, "Early Women in Education: The Role of the Anderson School of Natural History," in Boston University Journal of Education, 159 (Aug., 1977): 50-64.

(70) Mary E. Beaman Scrapbook, Mary E. Beaman Joraleman Papers (Hereafter as MBJ Scrapbook), Bancroft Library, University of California, Berkeley (hereafter as UCB). Beaman was a student at the Anderson School in 1873. Her scrapbook is composed of clippings from local newspapers, magazines, and journals.

(71) Letter to Mary E. Beaman from Elizabeth Cabot Agassiz, April 28, 1873, Mary E. Joraleman Papers, (hereafter MBJ Papers), UCB.

(72) Elizabeth Cabot Agassiz to Mary E. Beaman, April 28, 1873, MBJ Papers; MBJ Scrapbook, 1-2, UCB. Among the faculty were Arnold Guyot of Princeton, Count Pourtalès of the Coast Survey, and Bert G. Wilder of Cornell.

(73) Albert H. Tuttle, "The Harvard that I Knew," an address delivered before the Town and Gown Club of Berkeley, California (Feb. 21, 1916), 6, Albert H. Tuttle Papers,
UCB. Tuttle states that "The story may not be true; it is certainly ben trovato."


(75) MBJ Scrapbook, 1, UCB. There is disagreement in the sources as to how many women were admitted in 1873. According to local newspaper clippings in Joraleman's scrapbook, eighteen of the fifty students were women. However, David Starr Jordan, who was also a student at the time, recalled that fifteen women enrolled the first year. See Jordan's Days of a Man, 1, 108.

(76) MBJ Scrapbook, 1-10; 21, UCB.

(77) The incident is described by Jordan in The Days of a Man, 111-12.

(78) Quoted in Joan N. Burstyn, "Early Women in Education: The Role of the Anderson School of Natural History," 50-64. The source for the quote is Agassiz's opening address in the New York Tribune, July 9, 1873.

(79) MBJ Scrapbook, 1, UCB.

(80) Louis Agassiz to Burt Green Wilder, Dec. 7, 1872, box 1, Burt Green Wilder Papers, Cornell University Archives.

(81) Joan Burstyn, "Early Women in Education: The Role of the Anderson School of Natural History," 54-55. Elizabeth Cabot Agassiz stated that "the instruction is free" in a letter to Mary E Beaman, April 28, 1873, MBJ Papers, Bancroft Library.

(82) "Boston, Dec. 14;" "Feast and Fast;" "The Closing of the Anderson School of Natural History;" and "Twas Ever Thus;" in MBJ Scrapbook, UCB.
Chapter 6
The Nature Study Movement

Introduction

After the Civil War, a movement arose to promote the introduction of science in the nation's common schools; this prompted a debate among educators over which scientific subjects young children should study. Although a few astronomy, natural philosophy, and natural history textbooks had been published for the common school market earlier in the century, many educators now argued that the science most suitable for children in the first eight grades of school was natural history. The subsequent effort to introduce a version of natural history into the nation's common schools became known as the nature-study movement. Nature study gained national prominence during the last decade of the nineteenth century, and by 1925, it had found a place in the curriculum of virtually every school district in the nation.

The rise of the nature-study movement was meteoric, but its decline occurred with even greater rapidity. In the words of one scholar, the movement was "all but dead" by the early 1930s. As we shall see, throughout nature study's school history, a number of influential educators argued that nature study exerted a "feminizing" influence on boys; twentieth-century male critics habitually characterized nature study as "romantic" or "sentimental". The nature of
such assertions strongly suggests that gender played a key role in the movement's demise.

The ensuing discussion considers the following questions: What roles did women play in the evolution of the nature-study movement? In what ways did their modifications of the original nature-study curriculum continue some of the gendered traditions and stereotypes of the earlier natural history texts? To what extent can some of the criticisms of nature study be characterized as a repudiation of the increasing leadership of women in education? In addressing such questions in the following discussion, I aim to uncover the origins of an emerging conflict in gender relations in science education.

In order to understand what nature study was, and how gender issues affected the course of the movement, the discussion begins with a brief, general survey of nature study's swift rise near the end of the century. Next, the analysis focuses on the hitherto overlooked role of women in shaping the course of nature study in American schoolrooms.

The Rise of Nature Study

With the exception of a few unpublished dissertations, the nature study movement has received relatively little attention from historians. Most scholars have focused on one or two facets of nature study, providing a one-dimensional treatment of the movement. Thus, in the research literature, nature study has been variously characterized as the legacy of amateur botany, a progressive
movement in pedagogy, as a feature of the romantic back-to-
nature arcadian movement in the late nineteenth century, or
as the prototype of environmental education.⁴

One way to reconcile such varying explanations is by
conceiving the movement as a loose coalition of communities
composed of individuals, societies, and institutions able to
find some common ground in the study and appreciation of the
natural world. The swift rise of nature study on the
educational scene in the last decade of the nineteenth
century would not have been possible without the support of
this large and highly diverse coalition. And as we shall
see, in this very diversity lay some of the seeds of the
movement's later demise.

Viewing nature study as an outgrowth of the late
nineteenth century back-to-nature movement provides an
important social and cultural context within which to
understand nature study's widespread appeal. With the
emergence of a rapidly expanding industrial economy in
America during the latter half of the nineteenth century
came an increased nostalgia for a simpler, more rural life.⁵

Americans of the late nineteenth century commonly
expressed the belief that close ties to rural nature ensured
the continuity of traditional values and the development of
moral character. According to the well-known psychologist
and university president, G. Stanley Hall, when city
children were denied the opportunity to hunt, fish, climb,
and explore in the great outdoors, they increasingly
indulged in "hoodlumism, juvenile crime, and secret vice." Voicing an opinion evidently common during this period, the American writer Sarah Orne Jewett concluded that Flaubert's tale of Madame Bovary was "a lesson to dwellers in country towns, who drift out of relation to their surroundings, not only social, but the very companionships of nature, unknown to them."6

Behind the effort to introduce the study of nature into common schools lay an uneasy and pervasive concern that children would not grow up properly in an urban world. Nature writer John Burroughs popularized the contrast between rural paradise or urban hell:

> Even the simple birds understand not to build their nests in a place that is unclean and unhealthy, where their nerves are rattled, where loud noises assault the ear and foul smells [assault] the nose.7

According to the historian Peter Schmitt, a report by the psychologist G. Stanley Hall influenced many Americans to support nature study in their local schools. Published in 1891, Hall's paper described the effects of urbanization on "The Content of Children's Minds on Entering School." Hall had surveyed the nature knowledge of two hundred middle-class children entering first grade. The American public was surprised to learn that these children displayed an alarming ignorance of nature and country life. Fully 90 per cent could not identify a field of wheat or explain the origin of cotton or leather; 80 per cent could not identify
common trees, and 75 per cent expressed ignorance of the seasons of the year. Hall recommended classroom-based nature study to help city children recover an acquaintance with the rural countryside:

As our methods of teaching grow more natural, we realize that city life is unnatural, and that those who grow up without knowing the country are defrauded of that without which childhood can never be complete or normal.8

Nature study easily gained support among an influential portion of the public, one concerned with preserving the environment and elevating the status of country life. In 1908, the year in which the American Nature Study Society was formed (1908), the Federal government forged a political coalition that established 36 wildlife refuges and the Grand Canyon National Park. During the same period, Theodore Roosevelt called his famous Joint Conference of Governors, a conference which led to the establishment of conservation departments in almost all of the states; he also appointed a Commission on Country Life to investigate the status of rural life and formulate recommendations for improving rural conditions. Led by Cornell University's Liberty Hyde Bailey, the Country Life Commission held schoolhouse meetings across the country, asking questions and listening to the expressed needs of local communities. Newspapers and magazines joined in the propaganda campaign to elevate the status of rural life, printing stories about the healthfulness of living in the country, the virtues of
agriculture, and the benefits of nature study.9

An often overlooked contributor to the genesis of nature study was the community of amateur naturalists. According to historian Elizabeth Keeney, when professional botanists turned from natural history to laboratory plant biology near the close of the nineteenth century, amateurs found themselves with little room for involvement. As the interaction between professionals and amateurs declined, the latter began to promote botany as a worthwhile hobby among children. One early example of an amateur naturalist who turned to writing for children was Mary Treat (1830-1923), a frequent correspondent and collector for Charles Darwin, Asa Gray, Charles V. Riley, and others during the 1870s. In 1880, she authored a popular book, *Home Studies in Nature*; she also contributed articles on natural history to the children's magazine, *St. Nicholas*, and to the family magazine, *Hearth and Home*. Not content to promote natural history through writing alone, Treat started a young ladies club in 1893, inviting young women to meet every other week in her New Jersey home to discuss botanical, entomological, and ornithological topics.10

Nature study provided a forum within which amateurs from a variety of fields could promote natural history. In 1880, a Massachusetts schoolteacher named Harlan H. Ballard created the Agassiz Association to encourage children in the study of nature. Named in honor of Louis Agassiz, the organization grew rapidly. By the 1890s, it numbered more
than 20,000 young members in 1,200 chapters across the country. In the Association's first report, Ballard suggested that members assemble collections and keep a record of "whatever new or curious facts with regard to natural history we can find by our own observation." Ballard was also interested in promoting the study of physical phenomena. In his monthly reports, Ballard posed questions for children to answer, some of which related to physical science. In his first report, for example, he asked his young readers, "Does air weigh anything? Prove by experiment...How hot must water be before it boil?" Association reports in subsequent issues of St. Nicholas testified to children's varied natural history interests. For example, children's letters to the association in 1892 describe such observed phenomena as insects, amphibians, rocks and minerals, shells, fossils, and plants.

The primary aim of the Association's leaders was to promote nature study as an extracurricular interest rather than to introduce it into schools. The Association first announced its inception in the November 1880 issue of St. Nicholas, the nation's most popular children's magazine. In following years the Association published its minutes, correspondence, and small news articles in St. Nicholas and in such other popular child and adult magazines as The Observer, The Swiss Cross, Santa Claus, and Popular Science News. Agassiz Association chapters across the country promoted the first-hand study of nature by organizing
collection contests, field trips, arranging scientific
talks, and occasionally running correspondence courses.  

As nature study began to gain a place in the curricula of school districts across the country during the next two decades, amateur naturalists continued to influence the development of the movement through their publication of nature articles and stories. Teachers with special knowledge of some aspect of natural history contributed regularly to the official organ of the nature study movement, The Nature Study Review. Maurice Bigelow, professor of biology at Teachers College, Columbia University, founded The Nature Study Review in 1905 with the goal of providing some direction and focus for the various nature study groups then forming across the country. In the first volume, Bigelow announced that the Review would publish notes, reviews, and articles by "the leaders in science teaching." Although Bigelow did not mention any leaders by name, he probably had in mind such men as himself and others who composed the Review's editorial committee: Liberty Hyde Bailey of Cornell's School of Agriculture, H.W. Fairbanks, noted geologist and author, Clifton F. Hodge, professor of biology at Clark University, and J.F. Woodhull, professor of physical science at Teachers College, Columbia University. However, subscribers soon began asking for articles giving more concrete suggestions for lesson plans and activities. Amateur naturalists, many of whom were classroom teachers, were quick to meet this demand with
relevant articles.

Besides contributing articles to the *Review*, amateur naturalists authored a stream of nature books for children during the heyday of the nature study movement, from 1891 to 1916. Although educators insisted that children learn about nature from natural phenomena rather than from textbooks, many well-known nature-study leaders recommended integrating nature study and literature by having children read nature stories either preceding or following their nature-study investigations. Nature-study handbooks and courses of study often included lists of recommended literature, bearing such titles as "Dwellers of the Sea and Shore," "Our Winter Birds," "Glimpses of Nature for Little Folk," or "Ways of the Six-足ed." 

Of course, the group with the most direct influence on the introduction of nature study into schoolrooms was the community of professional educators. In his history of progressive education, Laurence Cremin depicted nature study as the creation of progressives Colonel Francis Wayland Parker and his associate Wilbur S. Jackman. Parker, whom John Dewey once referred to as "the father of progressive education," gained national recognition through his pedagogical innovations as superintendent of the school district in Quincy, Massachusetts, and later as principal at Cook County Normal School, Illinois. Born in 1837, Parker interrupted a career as a country schoolmaster to serve in the Union Army, where he attained the rank of colonel. On
return from service, he began to study the works of such contemporary European educational theorists as Johann Pestalozzi, Friedrich Froebel, and Johann Friedrich Herbart, and in 1872 he traveled in Europe for two and a half years to observe the leading pedagogical innovations of the time.20

Shortly after his return to the United States, Parker was given the opportunity to put into practice the theories he had acquired abroad. In 1875, the school board of Quincy, Massachusetts, hired him as superintendent, and shortly thereafter, under Parker's leadership, Quincy teachers abandoned their traditional textbooks and copybooks in favor of learning through observing, describing, and understanding. Thus was born what was termed "The Quincy Method." The Quincy school became the focus of national attention, and a stream of visitors came to observe the new methods at first hand. Parker's innovations were further disseminated by Lilia E. Partridge, whose The Quincy Methods Illustrated described many of the day-to-day lessons and practices of the school.21

The idea of having children study natural phenomena through direct observation was not entirely new to American educators. Pestalozzian ideas had appeared in journals, textbooks, and even several school programs after 1805 in the United States. At least a decade before Parker began to implement his methods in Quincy, an interpretation of
Pestalozzian methods called "object teaching" was already familiar to educators through the work of Edward A. Sheldon of the State Normal School in Oswego, New York. Object teaching, in which teachers expected students to learn from natural phenomena rather than books, was carried to schoolrooms across the country by graduates of Oswego Normal. During the same period, the first kindergarten was organized in 1857, and the development of kindergarten associations across the country did much to popularize Froebel's idealist philosophy. Additionally, professors at other universities and normal schools taught Herbartian ideas during the last decades of the century as part of an effort to develop a systematic approach to pedagogy.22 Parker's unique contribution was to introduce and synthesize European methods throughout an entire public school district.

While Parker institutionalized the observational study of nature in Quincy, the formal development of a fully realized philosophy and pedagogy of nature study fell to one of his later associates, Wilbur S. Jackman. Parker left Quincy in 1880, eventually assuming the principalship of Cook County Normal School in Chicago. There, he surrounded himself with a choice faculty, including Jackman of Harvard University, to whom he gave the task of devising a means of teaching science in the common schools.23

At Cook County Normal, Jackman developed a course of
study published in 1891 as *Nature Study for the Common Schools*. This was the first full-length treatment of the subject. As conceived by Parker and Jackman, nature study comprised all areas of science. Parker argued that while the sciences were isolated in name, they were intrinsically related and bound to each other. Because Parker and Jackman believed that no scientific subject should be learned in isolation, nature study integrated investigations in all areas of science through first-hand observation and experimentation. Through nature study, they argued, the entire school curriculum could be unified. "Botany, zoology, and mineralogy," claimed Parker, "are among the best possible means for the teaching of reading and language, [and] how to speak and write the English language correctly can be taught incomparably better by teaching physics than by using technical grammar."24

Jackman and Parker advocated fieldwork as the most appropriate method of studying the natural environment. While students might bring specimens to the schoolroom, Parker claimed that "the way to study a tree, a plant, a flower, is to see these objects in their habitat."25 Under Jackman's leadership, Cook County schoolchildren conducted trips through fields and along the shore of Lake Michigan. They recorded observations, made drawings, and performed calculations, thus correlating their nature study work with language, mathematics, and art. Outside their schoolrooms, students planned and laid out gardens, learning about the
effects of the environment on the growth of vegetables and flowers and the application of scientific principles to agriculture.26

In the 1890s, Parker and Jackman began to require students at Cook County Normal to undertake outdoor excursions as part of their preparation to become teachers. In 1896, the entire senior class in the Normal School, with a membership of over 500, made numerous excursions to such sites as Stony Island, the Desplaines Valley, Dune Park, the Purington clay pits, and local drainage canals for the purpose of studying nature in the rough. "Hereafter," reported a local newspaper,

compasses, clinometers, levels, magnets, hammers, trowels, acids, spades, knives, boxes, bottles, jars, railroad tickets and camping utensils will be quite as necessary to the up-to-date student in Colonel Parker's school as were the slates, sponges, pencils and chalks in the days of the Hoosier schoolmaster.27

Nature study initially found support among members of the scientific community. Such scientists as John Merle Coulter, botanist at the University of Chicago, applauded nature study as a vehicle for promoting botany among schoolchildren.28 Others, such as President Eliot of Harvard, supported efforts to move the study of the natural sciences away from textbooks towards the natural world.29 In 1893, a Bureau of Nature Study was formed in the Department of Agriculture at Cornell University to promote nature study instruction across the country, and a flurry of guides,
pamphlets, and courses of study soon ensued, published and distributed by agricultural experiment stations, land-grant colleges, private colleges and universities, and normal schools.30

Within a decade after the publication of Jackman's first course of study, a progressively faster-growing tide of nature-study articles and handbooks appeared on the educational market, along with three other important books: *Nature Study and the Child* (1900) by Charles B. Scott, instructor in nature study at Oswego Normal School, *Nature Study and Life* (1902) by Clifton F. Hodge, a biology professor at Clark University, and *The Nature Study Idea* (1903) by Liberty Hyde Bailey, dean of the School of Agriculture at Cornell University.31 Eventually, the tide of publications grew into a flood, and the author who boldly opened his preface by stating that "all progressive educators support nature study" could make this claim with some appearance of verisimilitude.32

The role of nature study in the curriculum was also given impetus by the Committee of Ten. In 1892, a committee of ten college and school leaders was appointed at the annual meeting of the National Education Association in Saratoga Springs, New York and given the charge of smoothing the transition from high school to college by making college entrance requirements more uniform. Charles Eliot of Harvard headed this group, which organized nine conferences on different areas of the curriculum, including three
separate conferences in science: one on physics, chemistry and astronomy, one on natural history, and one on geography. According to historian Theodore Sizer, the Committee of Ten's Report was an influential document used by secondary-school educators as they created or modified programs in schools. For example, astronomy, which the Committee recommended no longer be required for entrance to college, experienced a 50% decline in high school enrollment over the following decade. Such other courses as geology and meteorology, recommended only as electives, also experienced declines.\textsuperscript{33}

On the basis of the science conference reports, the Committee of Ten recommended that one hour per week be devoted to nature study in the elementary grades and that all work be undertaken without using textbooks.\textsuperscript{34} At the elementary level, school districts began to add nature study programs to their schools, and the amount of cities offering nature study increased dramatically between 1892 and 1925.

By 1925, to varying degrees almost every city in the country introduced a form of nature study into its schoolrooms. In that year, the American Nature Study Society published its first yearbook, which included a survey of the status of nature study teaching in the United States. The study reported data from 127 school systems in cities with a population greater than 5,000 and from 55 normal schools. Every school system responding to the survey reported that it offered nature study to its
students, although only roughly half of the cities offered the subject in each of the first eight grades (see Table 1). Of the 55 normal schools, 49 claimed to teach nature-study pedagogy to prospective teachers.\textsuperscript{35}

\begin{table}
\centering
\begin{tabular}{lcccc}
\hline
 & In all grades & In at least 6 grades & In at least 4 grades & 3 or fewer & Not offered \\
\hline
49\% & 25\% & 11\% & 15\% & 0 \\
\hline
\end{tabular}
\caption{Percentage of 127 School Systems Offering Nature Study in their Public Schools, 1925}
\end{table}

\begin{footnotesize}
\end{footnotesize}

\textbf{The Nature Study Curriculum}

What was nature study, as it appeared in published courses of study and in schoolrooms? And to what degree did the nature-study curriculum perpetuate the content and aims of earlier nature literature written for a female audience?\textsuperscript{36}

Based on the rhetoric in their prefaces, the authors of nature-study curricula had an enormous agenda for a pedagogical reform movement, spanning three areas: society, culture, and the environment (see Table 2). According to its various supporters, nature study would accomplish in one stroke the goals of the nature lover, the naturalist, the conservationist, the scientist, the moralist, the promoter
of culture, and the agriculturalist.

In continuity with the earlier eighteenth- and nineteenth-century natural history tradition, many authors invoked natural theology when extolling the benefits of nature study. Others claimed that nature study created an appreciation of nature and developed a love of beauty. "The aesthetic phases of nature's handiwork," claimed the noted educator Charles McMurry, "furnish limitless and constant opportunities for aesthetic appreciation and culture."38

What immediately strikes the reader of these handbooks is that the grandiose rhetoric in the prefaces was rarely reflected in the bulk of the texts. The content of the courses of study -- the lessons and suggestions for instruction -- included ideas for investigations in a variety of subjects, the majority of which were drawn from the broader and more pedestrian tradition of natural history and from relatively recent developments in experimental agriculture (see Table 3). For example, some lessons required students to compare the structure and habitat of various animal species; others asked students to conduct experiments to discover the effects of varying soils on plant growth. In these respects, nature-study handbooks bear some resemblance to biological science curriculum materials developed for elementary students during much of the later twentieth century.
Table 2

Percentage of Authors Stating Various Aims for Nature Study

<table>
<thead>
<tr>
<th>Aims</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>To develop observation skills</td>
<td>67</td>
</tr>
<tr>
<td>To integrate the curriculum</td>
<td>67</td>
</tr>
<tr>
<td>To create an appreciation of natural beauty</td>
<td>67</td>
</tr>
<tr>
<td>To increase scientific knowledge</td>
<td>60</td>
</tr>
<tr>
<td>To improve agricultural skills</td>
<td>53</td>
</tr>
<tr>
<td>To build moral character</td>
<td>47</td>
</tr>
<tr>
<td>To provide practical preparation for life</td>
<td>40</td>
</tr>
<tr>
<td>To encourage conservation</td>
<td>33</td>
</tr>
</tbody>
</table>

Source: Sixteen nature-study handbooks and courses of study.39

Table 3

Percentage of Nature-Study Handbooks and Courses of Study Including Various Scientific Subjects, 1891-1918

<table>
<thead>
<tr>
<th>Subject</th>
<th>Percentage of Texts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botany</td>
<td>100</td>
</tr>
<tr>
<td>Zoology</td>
<td>100</td>
</tr>
<tr>
<td>Geology/Mineralogy</td>
<td>86</td>
</tr>
<tr>
<td>Meteorology</td>
<td>62</td>
</tr>
<tr>
<td>Astronomy</td>
<td>54</td>
</tr>
<tr>
<td>Physics</td>
<td>54</td>
</tr>
<tr>
<td>Agriculture</td>
<td>23</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Data compiled from an analysis of 16 nature-study handbooks and courses of study.40

In other ways, the materials published for nature study were similar to earlier natural history texts developed for an exclusively female audience. For example, nature study authors emphasized the importance of studying living organisms in the field. Agassiz's famous phrase, "Study nature, not books," appeared in the prefaces of many nature
study texts. The first nature-study handbook, Jackman's *Field Work in Nature Study*, consisted almost entirely of questions aimed to direct investigation, as illustrated by these questions from "Field Work on a Swamp":

Study carefully the conditions under which the swamp is formed. What is the degree of slope of the general surface of the swamp and the surrounding country? How is the swamp drained?41

While no nature study authors after Jackman imitated his use of questions to such an extreme degree, most did use open-ended questions in their texts. For instance, although the handbook written by Anna Comstock of Cornell University (1911) provided some background information about each specimen to be studied, it also included questions that could not be answered without first-hand observation. In a lesson on the codling moth, Comstock directed students to the following observations:

Look at a wormy apple. How can you tell it is wormy from the outside? Can you see where the worm entered the apple? Was the burrow large or small at first?42

Comstock didn't provide the answer to the last question; presumably, when everyone observed the phenomenon, the answer would become evident.

Turn-of-the-century photographs of school children's nature study activities show children engaged in the kind of natural history promoted several decades earlier by the Agassiz Association: making collections of such items as
leaves, rocks, or shells, raising wildflowers and vegetables in school gardens, observing the life cycles of butterflies, recording the weather, sketching their observations of plants and animals, and so on. Photographs show boys as well as girls undertaking these activities, although the task of gardening was occasionally differentiated by gender. While the boys may have shoveled and hoed, in some schools, girls engaged in the presumably more genteel task of watering (see Plate 8).

In its continuity with the natural history tradition, nature study would undoubtedly have appealed to many girls. Many of the activities promoted in schools were quite similar to the extracurricular nature activities girls described in letters to their favorite magazines. Additionally, the nature literature children read in their nature study lessons often cast girls as nature's heroines, ready to preserve hapless wildlife from the wanton destructiveness of boys.

**The Role of Women in the Nature-Study Movement**

Nature study's affinity with the earlier natural history tradition was an important factor in the growing dissatisfaction with the movement that arose just after the First World War. But another key factor was undoubtedly the increasing visibility of women leaders in the nature study movement.
Although national leadership of nature study was in the hands of such men as Parker and Jackman at the turn of the century, from the outset female educators figured prominently in local efforts to implement nature study programs. For instance, in many places, district administrators hired female college and normal-school graduates to fill the new role of nature study supervisor.
Thus, Effie B. Mcfadden, a graduate in botany from Stanford University, supervised the creation of a nature study program in Oakland (California) City School District in 1897. When Mcfadden left Oakland in 1900 to join the faculty at San Francisco State Normal School, she was replaced by Bertha Chapman, who received a masters degree in entomology from Stanford in 1902. In the Los Angeles City School District, almost all of the local supervisors of the nature study programs were female. Many of the women who were most active in the American Nature Study Society were supervisors, including Jennie Hall of Minneapolis, Minnesota, Fannie Stebbins of Springfield, Massachusetts, Clelia Paroni of Berkeley, California, Elizabeth Peeples, of Washington, D.C., and Emelie Yunker, of Louisville, Kentucky. By the second decade of the twentieth century, nature-study supervisors had their own national organization, the National Supervisors of Nature Study and Gardening, whose president in 1928 was a woman, Theodosia Hadley. As late as 1946, a handbook, Occupational Planning for College Women, compiled by the Occupational Guidance Council, listed "nature-study supervisor" as an occupation for women.

Able women were drawn into seeking such positions in part because the work of a nature-study supervisor was multi-faceted. In addition to having the responsibility for implementing, coordinating, and overseeing a district's nature-study program at one or more school sites, many
supervisors held split positions in which they combined supervision with teaching. For example, Helen Swett, daughter of California’s one-time state superintendent John Swett, held such a position in the Alameda City School District from 1900 to 1902. Along with teaching botany and zoology classes in the local high school, Swett provided after-school nature-study training for elementary teachers, led field trips, assembled collections of specimens, built her own scientific apparatus, developed new curriculum, and supervised the teaching of nature study in elementary classrooms. Even her Saturdays were filled to the brim, as described in this letter to her fiance:

On Saturday morning I started off on my wheel towards Hayward, alone, in search of sunshine, fresh air, and a creek...My captures were as follows...: four sticklebacks, 2 small toads, one water snake; 2 small lizards; one pair of handsome orb-weaving spiders; 3 other spiders; one back-swimmer; 3 water boatmen; four grasshoppers of a species I had never seen before; watercress seed; a kind of green algae new to me; a new water grass; a dragon fly...and several small water forms which I have not yet had a chance to examine under the microscope. How’s that for one day’s haul?

For bright, talented women, the role of nature study supervisor could also serve as a stepping stone to career advancement. Occasionally, supervisors left school districts to join the faculty of normal schools, as did Effie McFadden; others, such as Bertha Chapman, who was president of the American Nature Study Society from 1928 to 1931, went on to assume leadership of national...
organizations.55 Some supervisors gained local, state, or even national recognition through the development and publication of nature study curriculum materials. For instance, Helen Swett developed several curriculum materials, some of which were published by the Alameda School District and shared with such larger neighboring districts as Oakland. As word of her work spread, she was asked to give presentations on nature study at meetings of the California State Teachers Association.56

The inclusion of nature study in the curricula of normal schools also created a new position for women in at least a few institutions: professor of nature study. According to a 1925 report, of the 143 member institutions of the American Association of Teachers Colleges, all were found to be offering natural science instruction, but only twelve had specific professors of nature study.57 In contrast to a professor of natural science, who usually emphasized pedagogical methods and content for secondary school, a professor of nature study emphasized methods for students in the first eight grades of school. Because professorships in nature study were rare, any teaching about the nature study course was handled either by professors of natural science or by lower-status instructors.

The most famous professor of nature study in America was Anna Botsford Comstock of Cornell University, sometimes referred to by contemporaries as the "Dean of American Nature Study." One of the first women to be awarded a
professorship at Cornell, she became widely known throughout the country as a nature-study teacher, writer, and naturalist. An artist as well, Comstock created wood engravings to illustrate the insects in the scientific texts of her husband, entomologist Henry Comstock. As a wife, naturalist, teacher, and scientific illustrator, Anna Comstock embodied many of the ideals of earlier generations of women who had hoped that their sex might find meaningful careers within natural history. In 1923, she was voted one of the twelve greatest women in America by the League of Women Voters.58

Whereas such men as Jackman, Bailey, Hodge and others authored most of the handbooks and courses of study that were published and used by teachers in planning their lessons, women had an enormous impact on the nature study curriculum as it actually appeared in schoolrooms. Because nature study was predicated on the idea of studying nature directly, textbooks could not be used in the nature study program. The books that children read in their nature study lessons were therefore either nature stories aimed to integrate literature with nature study, or such reference works as Mabel O. Wright's *Birdcraft: A Field-book of Two Hundred Song, Game, and Water Birds*. The authors of such stories were frequently women.59

Ultimately, the most important (and later controversial) effect of women's participation in nature study was to modify the subject so that it favored the
biological sciences. Because women more frequently chose to study the life sciences, they tended to emphasize biological topics in the curricula they developed and in the lessons they published in educational journal articles. As discussed above, the contributions of women amateur naturalists to the Review frequently emphasized the traditional topics of natural history. Similarly, one of the few handbooks authored by a woman, Anna Comstock's Handbook of Nature-Study, devoted 462 pages to animal life, 351 pages to plant life, and only 100 pages to an eclectic section entitled "Earth and Sky." Aware of the imbalance in her text, Comstock explained that she had omitted various topics in physics because her own training and professional work were in biology:

> It should also be stated that it is not because the author undervalues physics nature-study that it has been left out of these lessons, but because her own work has been always along biological lines.60

Potentially more irritating to some male curriculum authors was the fact that as consumers of published curricula, female teachers modified courses of study to favor biological topics. The case of the nature-study program in California's Oakland City School District illustrates this phenomenon. During the 1896-97 school year, a group of one hundred and twenty-five Oakland teachers agreed to work under the direction of Professor Oliver Jenkins of Stanford University, who volunteered to
assist in the development and implementation of a course of study for students in the first eight grades of school.61

Initially, the content of Oakland's course of study balanced the life and physical sciences. Students studied a wide range of both living and non-living things in their immediate surroundings, focusing on the activity of local organisms and their adaptation to the conditions of their environment. For example, fifth-grade students studied the evaporation of various liquids and solids, condensation, distillation, solution, and filtering, as they observed such natural phenomena as fogs, clouds, snow, rain, the formation of soils, and erosion.

Within a three-year period, however, Oakland's teachers, the great majority of whom were female, modified the nature-study program to emphasize the biological sciences. According to Oakland's 1900 Annual Report, teachers preferred to teach topics from the life sciences because experience led them to believe that such topics were more successfully learned by their students.62 We shall never know whether Oakland's students were indeed more inclined to learn about plants and animals than chemistry or physics, or whether the teachers' success with the life sciences arose primarily from their own greater familiarity with these traditional topics of natural history. Whatever the reason, in 1900, fifth-grade students studied the growth of the pistil in the flower, the earthworm, snail, and slug, and conducted investigations with magnets. The eighth-grade
curriculum, which had largely consisted of physical science topics the year before, now included only such biological topics as plant physiology and experiments with plants or animals.63

Whereas the curriculum modifications made by women teachers often occurred in the semi-private world of the schoolroom, women also began to exert a highly visible influence on the nature-study movement at the national level. The participation of amateur naturalists in the American Nature Study Society (A.N.S.S.) guaranteed women an increasing presence in the membership of that organization. Founded in 1908, with Cornell's Liberty Hyde Bailey as its first president, the Society selected The Nature Study Review to serve as its official journal and forum for the publication of notices, minutes, and correspondence.64 From its inception, the Society extended membership to all subscribers of The Nature Study Review, as well as to any individual or organization with an interest in nature study.65 As a result, subscriber-members were drawn from the ranks of educators, librarians, museum staff, and the membership of naturalist clubs, communities that often included large numbers of women. For example, some of the naturalist clubs that had membership in the American Nature Study Society were the St. Louis Nature Club, the Webster Groves Nature Study Society of Webster Groves, Missouri, the Bangor Bird Conservation Club of Bangor, Maine, and Wachung Nature Club, and the Pittsburg Nature Club. Women comprised
the majority of members in such organizations. For instance, of the 146 members in the Bangor Bird Club, only one was male, and the entire membership of the Pittsburg Nature Club was female; 55 percent of the Webster Groves Nature Study Society was female. Gradually, the addition of such groups had an inevitable impact on the gender of the A.N.S.S. membership. In 1909, only 39 percent of the Society's membership was female. However, two years later, the majority of individuals who renewed their subscriptions to The Review (and thus their membership to the Society) were female. By 1927, 63% of the members were women.

As their membership numbers grew, women gradually began to assume leadership positions in the American Nature Study Society (A.N.S.S). This trend was made possible by the Society's policy and organizational structure. Rather than develop a large central organization, the Society's officers encouraged the affiliation of local chapters. The goal of the A.N.S.S. was to serve as a national clearinghouse for the efforts of these local chapters and to coordinate work at the national level. In 1910, the A.N.S.S. had three chapters: in Chicago, St. Louis and Berkeley. By the following year, additional chapters had been established in Milwaukee, Rockford, Illinois, and New York. The formation of chapters required the cooperation of local members, many of whom were women. For example, in 1911, Fred Charles wrote a Miss Carrie N. Jacobs of Hamilton, Ohio about the possibility of forming a chapter in her community:
As doubtless you are aware, Prof. Davis of Oxford, Ohio, has been chosen to lead the American Nature-Study Society the coming year. We are endeavoring to organize local sections of the Society wherever interest warrants, and have been quite successful in carrying out the plan. It occurs to me that since you are near Mr. Davis, you and he might co-operate in the organization of a section at Hamilton.70

Because local chapters could put forward nominations for office, and members voted to elect officers of the A.N.S.S., the growing numbers of female members began to have an impact on the constituency of the Society's leadership. In the first year of the Society's existence, its officers were overwhelmingly male. Cornell's Liberty Hyde Bailey was president, Bigelow of Teachers College was secretary-treasurer, and the five vice-presidents included Clifton F. Hodge of Clark University, F.L. Stevens of North Carolina College of Agriculture, Vernon L. Kellog of Stanford University, W. Lockhead of Macdonald College, Quebec, and F.L. Charles of DeKalb Normal School. Among the ten directors was one woman: Ruth Marshall of the University of Nebraska.71 In 1911, the president, vice-presidents, and directors were all men drawn from the faculty of normal schools, land-grant universities, and private colleges. Gradually, however, some of the larger local chapters began to nominate and vote into office women who were prominent in their organizations. In this way, the St. Louis Chapter nominated and voted in Nellie Matlock of St. Louis; she served as Secretary-Treasurer for a number of years.
Eventually, women began to assume even the office of president of the A.N.S.S. Anna Comstock of Cornell was elected president in 1913-14; Bertha Chapman Cady of the Coordinating Council on Nature Activities was president from 1928-1931; later presidents included University of Maine entomologist Edith Patch (1937-38) and Ellen Shaddy Shaw (1939-40). In 1926, although the president was male, three of the four vice-presidents were female, as were six of the ten directors. This pattern was repeated throughout the rest of the decade.

By the 1920s, the national leadership of nature study appeared to have shifted from men to women. More potentially threatening to men was the fact that women often succeeded in obtaining positions in school districts and institutions of higher learning as nature-study supervisors, lecturers, and even as professors. And as women gained increasing influence in the movement, their modifications of the nature-study curriculum became more visible. Bringing to their work in nature study an ostensibly feminine culture developed by earlier generations of female educators and naturalists, women appeared to be promoting a form of science education directed more appropriately to girls than to boys.

Criticism of Nature Study

While many scientists, naturalists, and nature lovers supported the effort to bring nature study into common
schools, throughout the movement's history, nature study also had its share of critics. Some educators agreed with the prominent Herbartian Charles De Garmo, who opposed the idea of integrating the school curriculum around nature study. According to De Garmo, such a scheme involved too great an emphasis on the natural sciences. He believed that the history of human development indicated that while civilization had been possible without natural science, it could not have appeared without "culture knowledge." If forced to choose between science and culture, argued De Garmo, "we should keep the culture and let the science go."74 Other critics opposed the idea of setting aside the textbook to study nature directly from the field.75 Still others, many of whom were established or would-be teachers, did not appear to enjoy the potentially tiring outdoor excursions involved in fieldwork. When Helen Swett was a nature-study supervisor Alameda's schools in northern California, she noted that while teachers might accompany her on field trips and outdoor excursions to identify and collect specimens, they never seemed to venture out with their classes on their own. "Isn't it funny," wrote Swett, "that they can't--or don't--go just as well without me as with me."76

Another source of tension within the nature study movement was the uneasy coalition of amateurs and professionals. These two groups did not always see eye-to-eye on the aims and goals of nature study. For one thing,
the articles authored by amateurs evidenced a somewhat different motivation for nature study than those commonly expressed by the Review's editors, individuals who had been professionally trained in the sciences. For example, Bigelow stressed the importance of integrating, through the direct observation of nature, experiences with a variety of natural phenomena. While he noted that such experiences did not constitute science, they might serve as a foundation for later advanced scientific study. Although amateurs also supported this view, their articles often gave more emphasis to the motivations of the antecedent, nineteenth-century natural history tradition: enjoyment of nature, gentility, utility, exercise, and fun. An article fairly representative of the latter point of view was that by Isabella G. Diggins, a fifth grade teacher at Upsala St. School in Worcester, Massachusetts. Diggins explained the benefits of teaching children to plant a wild-flower garden:

The gathering and sowing of seed, the hunting for plants in the woods, the planting, watering, and tending--combined to yield a quality of knowledge and, more than that, a love for the flowers which no other kind of study could secure.

The books and articles of amateurs, so popular among teachers and schoolchildren, were the occasional targets of criticism by professionals. As long as amateurs described nature study as a form of experiment or investigation, professionals raised no objections; however, when amateurs introduced elements of nature appreciation, or
anthropomorphized plants and animals, presumably to render the content more interesting to young children, professionals registered complaints. For instance, in 1910, the Nature Study Review published an article by Emilie Yunker of Louisville, entitled "School Gardens in Louisville, Kentucky." In her article, Yunker described the nature study gardens in the Louisville schools as laboratories, in which children experimented to discover the appropriate depth of planting, and the necessity for light, heat, moisture, and good soil. Yunker subsequently published other articles in the Review, some of which were less well received. In 1911, Professor C.H. Robinson of the Normal School in Upper Montclair, New Jersey, wrote to the editor to complain about an article by Yunker entitled "Our Friends the Trees." This was a reading lesson for second grade children written in a very sprightly tone: "How wonderful are the trees! They give us nuts and fruit to eat...a dreary world this would be without our friends the trees." 

Charles's reply to Robinson suggests that he and other professionals in the American Nature Study Society encouraged the participation of amateurs primarily because they were necessary for the continued growth of the organization through the creation of local chapters. Wrote Charles, "Like yourself, I am not impressed by Miss Yunker's contributions, but I have been hopeful for a section in Louisville, and she is a local enthusiast."
Some critics began to target women specifically in their attacks on nature study, blaming them for the so-called feminization of American boys. According to the prominent psychologist G. Stanley Hall, women teachers were responsible for the prospective emasculinization of the male students under their charge. As early as 1902, Hall recommended Clifton Hodge's nature study book on the basis that it had been written by a man rather than a woman:

Lastly, many modern nature books suffer from what might be called effeminization. This is a book written by a man and appeals to boys and girls equally.82

Similarly, the botanist John Merle Coulter criticized women's supposed style of teaching, claiming that the "foolish and forced sprightliness of many primary teachers" tended to "repel rather than attract strong children." Coulter also opposed the use of literature in the nature study program, arguing that its use encouraged a preference for fantasy over facts. Boys in particular, claimed Coulter, wanted factual truth: "This attitude toward truth appears to be general among boys unless it has been unfortunately suppressed.83

Later critics, while not mentioning gender specifically, targeted for attack those elements of nature study that women appeared to find most appealing: the correlation of nature study with such other subject areas as literature and art, the emphasis on biological topics, and nature appreciation. S. Ralph Powers, professor of natural
science at Teachers College, Columbia University, targeted the rhetoric of nature study advocates when he complained about their "extravagant claims for emotional, esthetic, and disciplinary outcomes."

As discussed above, those most impressed with nature study's ability to promote emotional and aesthetic outcomes were amateur naturalists and classroom teachers, the majority of whom were women.

Although some critics targeted women specifically in their attacks upon sentimentalism, anthropomorphism, and the teaching style of primary teachers, it is important to bear in mind that during the course of the nature-study movement, such elements and methods were promoted with equal enthusiasm by both sexes. For example, in 1923, the Nature-Study Review published a story by a male educator entitled, "Bufo Junior, A Story for the Pupils When Rearing Tadpoles," in which a fairy describes the metamorphosis of a tadpole into frog. This tale, and others like it, drew ridicule from critics who decried such methods as sentimental and romantic. Similarly, many male nature-study authors anthropomorphized plants or animals in order to render the content more interesting to young readers. For example, Purdue University's professor of agriculture James Troop authored a nature-study leaflet in which he mingled fantasy with factual information:

[Mr. Mosquito] is a bashful fellow, and is always found hiding in some out-of-the-way place, such as swamps and woods, while his mate amuses herself by trying to sing us to sleep so that
she may have a good chance to stab us with her little spear and suck our blood.86

The use of fairy tales, anthropomorphism, and an engaging teaching style had some important supporters as well as critics. The most famous was the prominent Herbartian, Charles McMurry of Illinois State Normal University. In answering the critics who opposed the teaching style of primary teachers, McMurry explained that many educational theorists of the day approved the use of such methods to motivate and interest the youngest children. McMurry was correct. During the late-nineteenth century, educators who sought to develop a curriculum suitable for kindergarten and the first grades of elementary school revolted against traditional methods that had been passed down from the universities and secondary schools. In their efforts to adjust schooling to the nature of the young child, many so-called progressive educators touted the benefits of fairy tales and fantasy literature, experiential learning, and stimulating teaching methods.87

The widening gap between classroom teachers and science educators in institutions of higher learning undoubtedly contributed to growing tensions in the nature-study movement. During the early stages of the nature study movement, its advocates, many of whom had received a college education in science, did not hesitate to use rhetoric tied to the earlier traditions of the natural history tradition. Nor did they hesitate to use a sprightly tone when writing

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curriculum materials, or to convey scientific principles within the form of a story. But as the professional scientific community increasingly developed an ideology of objective research divorced from such elements as nature appreciation or natural theology, science educators became more critical of such elements as they appeared in classroom nature-study lessons.

Although many such women as Anna Comstock and Helen Swett were professionally trained in science, women appear to have been surprisingly tolerant of the contributions of classroom teachers and nature writers to nature study. In fact, during her tenure as editor of the review from 1917 to 1921, Comstock seems to have encouraged the inclusion of articles by teachers in the Review as a means of broadening its appeal among classroom teachers. Comstock's efforts perhaps were motivated by a desire to bridge the growing gap between science educators in institutions of higher learning and teachers in elementary schools.88

Conclusion

By the 1920s, women appeared to have gained control of the American nature study movement. Not only had they filled positions as nature-study supervisors in local school districts and as lecturers and even professors in institutions of higher learning, they had also risen to leadership positions in the movement's central organization, the American Nature Study Society.

Women brought what critical contemporaries perceived to
be a distinctively feminine culture to their work in nature study. Of course, the culture that was being perceived as feminine was in fact quite similar to the amateur natural-history culture in which both sexes had participated earlier in the century. At the dawn of the nineteenth century, Americans would not have thought it unmanly for a male naturalist to enjoy nature literature, to express appreciation of nature's beauty, or to make references on occasion to the "glory of God's handiwork." As we have seen, even at the close of the century the majority of the nature-study handbooks and courses of study developed by men included such elements.

How, then, did the culture of amateur natural history come to be perceived as feminine? An important part of the answer is that the century's end, the cultural differences between amateurs and professionals in the scientific community had grown enormously, and the two groups were increasingly divided by gender. The majority of amateurs involved in nature study were now women, whereas the vast majority of professional scientists and professionally-trained science educators were still men. Women's references to natural theology, culture, and nature appreciation became easy targets for nature study's critics, not because females alone made such references, but because women were so much more visible than men, comprising the great majority of elementary school teachers and an increasing majority of nature-study leaders.
Male critics reacted negatively to women's modifications of the curriculum, their rhetoric, and their style of teaching. As we have seen, women did alter the curriculum materials developed by some male educators to include many of the elements of the earlier nineteenth-century natural history tradition. In subject matter, women maintained the connection between nature study and natural history by highlighting the biological, rather than the physical sciences. In their rhetoric, women often emphasized features of nature study that previous generations of female writers had identified as highly compatible with cultural views of women's sphere, such as nature appreciation, conservation, or natural theology. The teaching style that elementary teachers brought to their primary classrooms, coupled with a tendency to anthropomorphize plants and animals in stories directed to children in the first years of school, became a frequent target of some educational spokesmen who declared such methods unscientific and potentially harmful to boys.

As women began to compete directly with men for leadership positions in science education, the allegedly feminine culture they brought to nature study became an easy target for a political backlash supported by underlying social and economic concerns. During the early stages of the nature-study movement, male educators tolerated, however uneasily, the contributions of women only as long as they needed women's help in promoting and developing a network of
support for nature study, and as long as women assumed subordinate or passive roles in developing and implementing nature-study curriculum in schoolrooms.

As the next chapter will show, the repudiation of nature study came at precisely the time when women were no longer needed to advance the cause of science in common schools. It also occurred within the context of a more general public reaction against women's growing migration from the home to the paid workforce. And as we shall see, it is during the subsequent period of backlash and reform that we can begin to trace the cultural demise of science as an area of female interest.

Notes


(3) Tyree Goodwin Minton, "The History of the Nature-Study Movement and its Role in the Development of Environmental
Education," 139.


(7) Renehan, John Burroughs, 127.


(13) Keeney, The Botanizers, 140-41.


(16) Fred L. Charles to Gentlemen of the Houghton Mifflin

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Company, Jan. 23, 1911, box 6, American Nature Study Society Records (hereafter as ANSS), Cornell University Archives (hereafter as CUA.) Charles wrote, "The membership in the American Nature-Study society has materially increased during the past year. Teachers throughout this country and Canada are finding it very helpful." Women members often wrote to Charles recommending articles or talks by other women. For example, see Charles to Emily Westberg, Feb. 17, 1911, box 6, ibid. Charles replies, "I should be glad indeed to see the paper by Mrs. Ford on 'Lessons from Nature,' which you suggest be published. Could you obtain it for me?"

(17) I have chosen 1891 as the starting date for a period I describe as "the heyday" of the movement. In this year appeared the first published course of study, Wilbur Jackman's Nature Study for Common Schools. From then until 1916, education journals and popular magazines often published accounts of nature study; after 1916, such references dropped dramatically from the literature. References to nature study increased again from 1922 to 1929, but during this later period, many of the articles were highly critical of the movement. This conclusion is based on an analysis of the publications listed in Education Literature, 1907-1932, ed. Malcolm Hamilton (New York: Garland Publishing, 1979), volumes 1-25.

(18) These titles are drawn from the list of reference and literature books included in Anna Comstock's Handbook of Nature Study (Ithaca, New York: Comstock Publishing Co., 1927 [1911]), 924-932.


(21) "The Parker Anniversary," (Quincey, Massachusetts, April, 1890), file 3, box 1, in Francis Wayland Parker Papers, UCSC; Lelia E. Partridge, The Quincey Methods Illustrated; Campbell, Colonel Francis W. Parker, The Children's Crusader, 79.

(22) Will S. Monroe, History of the Pestalozzian Movement in the United States; Nina C. Vandewalker, The Kindergarten in American Education; Charles De Garmo, Herbart and the

(23) Richard R. Olmsted, "The Nature-Study Movement in American Education" (Ed.D. dissertation, Indiana University, 1967), 29-32; "The Normal" (1889), a news clipping in Parker Scrapbook 7, UCSC. The clipping states that "W. J. [sic] Jackman, a Harvard graduate, takes the position of teacher of science." See also "The Cook County Normal School, 1891" in ibid., which states: "[Jackman] is attempting the solution of that great problem, "How to teach science in the common schools." At Cook County, Jackman replaced Henry Straight, the man Parker had initially chosen to develop a program of science education. Henry and his wife Emma had both been students of Louis Agassiz at the Anderson School of Natural History; afterwards, they had assumed positions at Oswego Normal School, from which Parker recruited them. Straight's career at Cook County was cut short when he died unexpectedly of a heart attack at age 40. For a brief discussion of Straight's contribution to the nature study movement, see Olmsted, "The Nature-Study Movement in American Education," 29ff.

(24) Parker, "A Sketch of the Work in the Quincy Schools from 1875 to 1880, Part V," *The School Journal* (August, 1885), Parker Scrapbook 6, UCSC.

(25) Parker, "The Value of Field Excursions," *The School Journal* (Feb. 11, 1899), Parker Scrapbook 12, USCS.

(26) "Characteristic Normal Schools: Chicago and Cook County Normal School," a clipping in Parker Scrapbook 12, UCSC. A penciled note gives the date as 1896; Anna de Koven, "The Pioneer of the New Education in America," in *The Illustrated American* (no date given), Parker Scrapbook 12, UCSC.

(27) "Fad May Lead to Strife," newscutting in Parker Scrapbook 12, UCSC. A handwritten note gives the date as Oct. 7, 1896. According to this article, some students opposed the requirement to do fieldwork.


(29) Eliot was quoted as stating that "natural science is to be studied not in books but in things..." in "Education in 1884," in *Journal of Education*, in Parker Scrapbook 6, UCSC.

(30) Anna Botsford Comstock, *Handbook of Nature-Study*


(35) "Preliminary Report of Committee on School Progress," in *First Yearbook of The American Nature Study Society* (Toledo, Ohio: The American Nature Study Society, 1925): 3-7. Cities from 22 states and the District of Columbia are represented in the sample. There is no indication in the published report as to whether this was a randomly selected sample or simply a poor rate of response to a questionnaire mailed to every state. Since the author mentions "cities not yet reached by this investigation" (6), it is possible that the survey was never intended to encompass every state.

(36) The following discussion is based on an analysis of sixteen nature-study handbooks and courses of study published between the years of 1891 and 1932. The authors of these materials included educators and scientists from normal schools, private universities, land-grant colleges, and public schools. This sample represents 42 percent of all such published materials I have identified to date. For the purposes of this study, a handbook is defined as a text for teachers containing information about the aims, principles, and methods of nature study. A course of study is defined as a graded or ungraded sequential curriculum. Many of the texts included in this study are a combination of both handbook and course of study.


(40) Ibid.


(43) For example, see photographs of children's nature-study work included in Jackman, "Nature Study," in *The Third Yearbook of the National Society for the Scientific Study of Education* (Chicago: The University of Chicago Press, 1904). Another source of photographs are city school reports. For instance, the 1914 report of the Los Angeles City School District includes photographs of students collecting specimens on a hillside and at a beach. See *Annual Report of the Board of Education of the Los Angeles City School District, 1913-14* (Los Angeles, 1914), 92.

(44) The photograph, which depicts a school garden from an unknown school, is from the Wisconsin State Historical...
(45) See Chapter 5, above.


(48) In Los Angeles, Charles Lincoln Edwards served as director of nature study. The direct supervision of nature study work in schools was undertaken by assistant supervisors. In 1924, Edwards listed eight "past and present Assistant Supervisors of Nature Study," of whom 7 were women. See Charles Lincoln Edwards, Nature-Study, Part I (Los Angeles: Hesperian Press, 1924), vii.

(49) Jennie Hall's role as supervisor is mentioned by Theodosia Hadley in a letter to E.L. Palmer, July 6, 1928, file 10, box 2, ANSS, CUA; Fannie Stebbins, Clelia Paroni, and Elizabeth K. Peeples are mentioned in a letter from L. Lenore Conover to Charles L. Pack, Nov. 16, 1925, file 3, box 2, ibid.; Emelie Yunker is mentioned in the manuscript entitled "American Nature Study Society," July 3, 1929, file 3, box 3, ibid.

(50) Theodosia Hadley to E.L Palmer, May 29, 1928, file 10, box 2, in A.N.S.S. Records, CUA.


(52) "Helen Swett," The Stanford Alumnus, 12 (March, 1911): 216.

(53) Swett to Schwartz, August 26, 1900, in Helen Swett Papers, Bancroft Library Archives, U.C. Berkeley.

(54) Swett to Schwartz, September 2, 1900, in Helen Swett Papers, Bancroft Library, U.C. Berkeley.

(55) E. Laurence Palmer to Richard L. Weaver, April 29, 1943, box 3, ANSS, CUA.

(56) Swett to Schwartz, November 10, 1900, box 2, in Helen Swett Papers, Bancroft Library.

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See William G. Vinal, "Report of the Committee on Preparation of Teachers," First Yearbook of the American Nature Study Society (Toledo, Ohio: The American Nature Study Society, 1925), 8-19. Such positions were still relatively rare, however. According to Vinal's report, of the 143 members of the American Association of Teachers Colleges, all were found to be teaching natural science, but only twelve had professors of nature study.


Of the sample of 16 nature study handbooks and courses of study examined here, only one was solely authored by a women: Anna Comstock's Handbook of Nature Study. Alice Jean Patterson of Illinois State Normal University co-authored another, Practical Nature Study and Elementary Agriculture. On the other hand, of a sample of 47 nature study readers, 23 were authored by women, 16 by men, and 8 were coauthored by a combination of men and women. This sample of 47 readers comprises all of the texts found on one shelf in the textbook collection of Cubberley Library, Stanford University, from number 518.3 J52 to 518.3 T863v.1.


Annual Report of the Public Schools of the City of Oakland for the Year Ending June 30, 1897 (Oakland: R.S. Kitchener, 1897). The report states that one hundred and twenty teachers initially worked with Professor Jenkins. There is some confusion over the exact figure, since Oakland's 1904 report states that seventy teachers initially worked with Jenkins.

Oakland Annual Report, 1900, 8.

Ibid.

Fred L. Charles to Philip Dawell, Jan. 13, 1911, box 6, ANSS, CUA. In this letter, Charles explains that the Review is the official journal of the American Nature-Study Society.

Fred Charles to Frank C. Patten, Jan. 16, 1911, box 6, ANSS, CUA.

The Society's records include membership lists of

(67) The 1909 figure is based on a random sample of 273 members listed alphabetically from Albert to Lamont published in The Nature-Study Review 5 (March, 1909), 3. The information about membership renewals in 1911 is found in Fred L. Charles to Emily C. Westberg, Feb. 17, 1911, box 6, ANSS, CUA. The figure for 1927 is compiled from a list of members in "Members of the American Nature Study Society Who Sent in Their Dues to the Secretary-Treasurer," file 6, box 3, ibid.

(68) Charles to the Assoc. Editorial Service, Jan. 30, 1911, box 6, ANSS, CUA.

(69) Fred L. Charles to B.M Davis, Jan. 19, 1911, box 6, ANSS, CUA; Charles to Miss L.L. Wilson, Feb. 19, 1911, ibid.

(70) Fred L. Charles to Miss Carrie N. Jacobs, Feb. 1, 1911, box 6, ANSS, CUA.

(71) Bigelow, M., "First Meeting of American Nature-Study Society--Report of the Secretary," in Nature-Study Review 4 (January, 1908). In the first year, Liberty Hyde Bailey of Cornell was president, Bigelow of Teachers College was secretary-treasurer, and the five vice-presidents included: C.F. Hodge of Clark University, F.L Steavens of the North Carolina College of Agriculture, V.L. Kellog of Stanford University, W. Lochhead of Macdonald College, Quebec, and F. L. Charles of DeKalb Normal School. Among the ten directors was one woman, Ruth Marshall of the University of Nebraska.

(72) E. Laurence Palmer to Richard L. Weaver, April 29, 1943, box 3, ANSS, CUA.

(73) "Minutes of the Kansas City Meeting," file 3, box 3, ANSS, CUA; Palmer, "Fifty Years of Nature Study," 475, 477, 478.

(74) Charles De Garmo, "Colonel Parker's Theory of Concentration," Parker Scrapbook 10, UCSC. This newscutting does not indicate the source or date.

(75) A Conservative Progressist [sic], "Opposition to the 'New Education'", in The Journal of Education (Feb. 11,
(76) Helen Swett to Charles Schwartz, April 9, 1901, box 2, Swett Papers, UCB. See also Pepoon, "Botanical Field Work in Secondary Schools," 416. Pepoon noted that the majority of high school students "do not take kindly to field work, as representing too much physical labor, perchance."


(81) Fred L. Charles to Prof C.H. Robison, March 18, 1911, box 6, ANSS, CUA.


(83) Coulter, Coulter, and Patterson, Practical Nature Study, 35-39; 68.


(88) Comstock's editorship is discussed in Olmsted, "The
Nature-Study Movement in American Education," 55-8. Olmsted characterizes Comstock as a romantic because she includes such articles by amateurs.
Chapter 7
Backlash and Reform

Introduction

By the last decade of the nineteenth century, girls outnumbered boys in public high-school science courses across the country. In some institutions of higher learning, greater percentages of women than men received undergraduate degrees in botany, zoology, and mathematics. However, at the turn of the century, this state of affairs began to change. As historians have noted, the subsequent three decades witnessed a decline in girls' science enrollments at both the secondary and post-secondary levels.¹

In seeking an explanation for this phenomenon, some scholars have looked to the barriers erected against women by the increasingly professionalized male scientific community. As documented by the historian Margaret Rossiter, such obstacles were formidable indeed, serving to severely limit the extent of women's participation in science. Nevertheless, developments in the professional science community do not constitute an entirely satisfactory explanation for the decline in science enrollments in secondary and post-secondary schools, because the majority of girls in these institutions studied science, not to become professional scientists, but to become science teachers.²
To understand the phenomena affecting females, it is necessary to investigate the extent to which members of the education community may have created organizational barriers of their own to bar women from careers in science education. As demonstrated in the previous chapter, women gained control of the leadership of the American Nature Study Society in the twentieth century. What was the reaction of the male education community to this development? Were women able to gain comparable footholds in other professional science education associations? To what degree can women's exclusion from science education be viewed as a direct result of the professionalization of the field? These and other questions are addressed below.

### The Backlash Against Women Teachers

The late-nineteenth century was a period marked by a growing cultural backlash against the visibly increasing numbers of women in the teaching force. The industrialization of the northern and eastern states, the construction of railroads, and the migration of pioneers westward, created so many employment opportunities for men that the growing numbers of schools could no longer hope to attract male teachers to stem the "feminization" of schools. Given their relatively limited employment opportunities, women continued to fill the growing number of teaching positions across the country. Because women commanded lower salaries than men, this state of affairs naturally appealed to school boards looking for cost-effective ways to educate
their school-age populations. By the 1890s, women comprised 65 percent of the nation's teachers. The proportion of women teachers steadily increased thereafter, until it reached its historically highest point, in 1921-22, when 87% of elementary and 64% of secondary teachers were women.3

Earlier in the century, educational leaders justified the employment of women teachers as a relatively inexpensive means of providing instruction to children in common schools. Before the Civil War, Henry Barnard, editor of the American Journal of Education, wrote persuasively that "every instance of the employment of a female teacher in place of a male...will save one half of the wages paid to the latter."4 Some state superintendents took care to give additional reasons for hiring females, perhaps in order to allay the fears of community members who may have feared that quality was being sacrificed to thrift. For example, in 1856, after citing financial reasons for hiring women, Wisconsin's state superintendent added that females by nature were more qualified to teach the young:

Females, in consequence of their higher moral instincts, their more refined tastes, together with their more patient and sympathizing natures are fitted in a more eminent degree than the male sex for imparting instruction to the young.5

The proportion of female teachers increased dramatically during the Civil War years, and their number continued to grow after the end of the War. For example, in the Indiana of 1812, Oliver Johnson remembered that "there
was no such thing as a woman teacher. It wasn't a woman's job, any more than milking a cow was a man's job."

However, this state of affairs did not last long. From 1859 to 1864, the percentage of women common-school teachers in Indiana more than doubled, from 20 to 46 percent. In discussing this trend, Indiana's state superintendent George W. Hoss concluded that the rise of women teachers in his state was "a cause for congratulation [rather] than alarm."

Hoss believed that women were "more likely to engage permanently in the business of teaching than young men" and for this reason would "devote more attention to their preparation for teaching." By talent and by disposition, he argued, women were highly qualified to teach:

Very few...who have had experience in the practical process of common school instruction... will or can hesitate to give females the preference over males, as teachers of all primary and secondary schools.

After justifying women teachers on the basis of their inherently superior ability to teach, Hoss went on to give what was probably the more compelling reason Indiana's school boards preferred women to men: "The extensive employment of young ladies as teachers, tends to lessen the cost of the schools...they do not generally ask or expect so high a rate of compensation as young men do."

In a similar vein, Newton Bateman, the state superintendent of Illinois, characterized the increase of women teachers in his state as a development "which no
friend of common schools ought, in my estimation, to deprecate." During the Civil War, he pointed out, women had assumed the common-school positions vacated by men, and the results of their classroom labors had demonstrated, upon a grand scale, their "eminent fitness and capacity...as teachers of youth." Leading educators from various regions of the country reiterated such views up to the last decade of the nineteenth century. For instance, as late as 1891, William T. Harris, the United States Commissioner of Education, along with the superintendents of eight cities, informed an English educational commission that women teachers were as effective as men in "giving intellectual training" and "in maintaining discipline and order." By this period, however, a growing number of critics began to contest the views of Harris and other educators supportive of the policy of hiring women.10

The reaction against women teachers in the late-nineteenth century was part of a more general public response to women's growing migration from the home to the workforce. By 1890, women were pouring into factories and offices, graduating from secondary schools and colleges in record numbers, and competing with men to fill positions in the learned professions. In 1906, the popular magazine Public Opinion carried an article entitled, "Industrial Competition of Women with Men," in which the author described the "rate of increase of the number of women in the five greatest groups of occupations: agriculture,
professional service, domestic service, trade and transportation, and manufacturing [as being] greater than the rate of increase of the female population." Among those entering the workforce in record numbers were middle-class women, whose employment had increased at an even greater rate than that of working-class women. Most unsettling to some, women were also campaigning for higher wages and the right to vote. In reaction, a number of late-nineteenth-century male commentators sounded the alarm that American culture and American institutions were weakened by becoming "womanized" or "feminized."

Among educators, an important argument against women teachers was the relatively poor academic performance of boys in high-school classes. Earlier in the century, when the two sexes had been educated in separate schools or departments, Americans had not been concerned to compare the academic performance of boys and girls. However, with the rise of coeducational public high schools, in which males and females studied the same curriculum side by side, it became only too easy to compare the relative performance of boys and girls—and to see that greater numbers of boys were failing in their studies. For example, J. E. Armstrong, principal of Englewood High School in Chicago, reported that "the boy, during his first two years in high school, finds himself unable to carry his work beside his more mature sisters." According to Armstrong, 20 percent of the girls graduating from his school "attained an average of 90% in
all their studies, while only 2% of boys attained similar results. "In all branches," wrote the author Josephine Conger-Kaneko, "the girls frequently excel the boys. Later, in their higher studies, too, the girls carry off the majority of honors and medals." Cognizant of such schoolroom trends, Walter F. Wilcox of Cornell University warned that women were advancing faster educationally than men:

> The young women of this country are now more generally able to read and write than men of corresponding age...if this trend of change continues for a generation, elementary and higher education will be possessed more generally by women than by men.

Educators noted with increasing anxiety the low enrollments of boys in public high-school courses. For example, the city superintendent of Omaha, Nebraska, noted in 1886 that, "Quite generally boys drop out of school as they reach the higher grades and graduating classes are frequently entirely composed of young ladies." In 1889, the United States Commissioner of Education William T. Harris estimated that only 25 percent of students in the high schools of the ten largest cities were boys. Some educators worried that the male attrition from high school would lead inevitably to "a comparatively ignorant male proletariat opposed to a female aristocracy." Consistent with their greater persistence in high-school, in 1890, a preponderance of girls filled high-school
science and mathematics courses (see Table 1). The only high-school subject in which boys apparently outnumbered girls was trigonometry, in which boys had a slight enrollment advantage. However, unlike algebra or geometry, few students ever enrolled in trigonometry classes; in 1900, only 2.4 percent of boys and 1.5 percent of girls studied the subject.18

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>19,125</td>
<td>26,912</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8,415</td>
<td>12,064</td>
</tr>
<tr>
<td>Algebra</td>
<td>38,505</td>
<td>53,360</td>
</tr>
<tr>
<td>Geometry</td>
<td>18,445</td>
<td>24,708</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>5,184</td>
<td>4,545</td>
</tr>
</tbody>
</table>

Source: John Francis Latimer, What's Happened in Our High Schools? (Washington, D.C., Public Affairs Press, 1958), 149.19

Some observers explained this phenomenon in terms of development. In comparison to more mature girls of the same age, boys were "rough, developing adolescents; healthy young cubs." As such, explained William Lee Howard, a Baltimore physician, boys "have not learned to apply their minds to books, and the healthy boy of seventeen must be expected to be far behind girls of the same age in this matter."20 G. Stanley Hall, a psychologist and president of Clark
University, also argued that boys must pass through a "raw period" of revolt in order to move to "virile manhood." The views of Hall, Howard, and others found a ready audience in an era that exalted virility. Theodore Roosevelt, America's most influential proponent of masculine culture, wrote to Hall to express his agreement that "Over-sentimentality, over-softness, in fact, washiness and mushiness are the great dangers of this age and this people."21

In seeking an explanation for boys' low enrollments and relatively poor academic performance, some educators claimed that the woman teacher's feminizing influence was driving boys away. In 1891, Commissioner Harris reported that many schoolmen believed that "the increasing femininity of the schools" was a principal reason for the "already noticeable decrease in the proportion of boys in the higher grades."22

Critics identified a variety of means by which female teachers allegedly repelled boys from schools. "Women teachers," wrote William Lee Howard, "do not appeal in any way to the virile or feral qualities of [boys]. The want of rapport naturally causes the boys to remain indifferent in their lessons."23 G. Stanley Hall argued that adolescent boys needed the stronger, sterner discipline of a male teacher, because "[the boy] is now living through that state of the world where fear ruled and law was enforced by punishment; and he is liable to be a little spoiled under a regime of sugary benignity."24 Echoing this view, the president of the Boston Schoolmaster's Club claimed that the
woman teacher weeded out of school "pupils she deems undesirable that she might have a prettier class or an easier time."^{25}

Some commentators questioned the ability of female teachers to challenge boys intellectually. In 1891, an editorial in the journal *Education* portrayed the young women teaching in elementary schools as "absolutely ignorant of the history, science and superior methods of instruction in education." Placed in control of a "raging crowd of children," the souls of such teachers grew "benumbed by the effort of 'reading the riot act.'"^{26} Similarly, in 1889 a National Education Association committee on education in normal schools expressed the view that the "country girl" seeking to become a teacher would "be found to be ignorant or deficient in all the branches to be taught."^{27}

In general agreement with this view, Julius Sachs of Columbia Teachers College claimed that American boys left high school before the end of the four-year course because the inferior instruction of female teachers "lacks the stimulus of highest attainment which is wholesome to every young man; the superfluous energy goes to waste in an exaggerated cult of athletics."^{28}

As a solution to the problem, some educators proposed taking measures to attract more men to teaching. "Boys will never receive the best education as long as they are taught chiefly by the opposite sex," argued one author. Superintendent J.W. MacDonald of Stoneham, Massachusetts 286

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claimed that if men could be retained in classrooms, "the silent influence of noble, manly goodness...[would] make textbooks on morality a needless encumbrance."  

During this period, school boards in some cities began to take measures to reduce the proportion of women teachers in their schools. In 1883, the *Women's Journal* reported that the Cleveland Board of Education contemplated replacing its women principals with men; the journal exhorted its readers to organize and oppose the move. In 1887, Philadelphia's school board discovered that of nearly 3000 teachers in the grammar schools, only 126 were male. The board immediately took steps to establish a school of pedagogy for men to remediate matters. Furthermore, the board announced that men would be hired in preference to women in the two highest grades (seventh and eighth) of the boys' grammar schools. In 1892, a controversy arose in Chicago over an educational commission proposal that, among other things, would employ more male teachers and pay them higher salaries.

Opposition to women's numerical dominance in American classrooms and increasing presence in administrative offices arose from the ranks of conservative women as well as from men. In 1892, Caroline Corbin, a leading anti-suffragist and president of the Illinois Association Opposed to the Extension of Suffrage to Women, led a group that opposed women school administrators on the basis that they posed an "emasculating threat" to the school. This echoed the
concern of some male educators that even fewer men would enter teaching if the principal's office was reserved to women.

Corbin, a conservative Christian, based her defense of the status quo on the argument that attempts to provide equal rights for women in the workplace and political arena would inevitably lead to the abolition of property and marriage. "Socialism, with its plan of turning women loose in the world...to the neglect of their own inherent and inalienable rights and duties, and the destruction of the home...is pulling down the roof-tree to boil the kitchen pot." For Corbin, as for other conservatives, the attempts of some women to venture beyond the bounds of their God-given role in the home threatened to undermine the fabric of society. Such anti-suffragist views were rigorously countered by those in favor of greater rights for women, feminists who disseminated their views through such publications as the Woman's Journal.31

American anxiety about the number of women in the classroom, particularly in the upper grades, was exacerbated when European commentators declared, in several reports published between 1900 and 1910, that American boys were suffering from the feminization of women teachers. Most embarrassing to educators was the observation of Henry Armstrong of England's Mosely Commission, that "there is a strange and indefinable feminine air coming over the men...a tendency towards a common, if I may call it, sexless tone of
thought." Armstrong believed that American schools reflected "a distinctly low average of attainment," as a result of coeducation. "The boys," he claimed, assumed the lower standard of the girls, which was "far below that of the English schoolboys of comparable grade."  

Adding fuel to the fire was Frenchwoman Marie Dugard's report to the French minister of public instruction. Dugard claimed that the American educational system suffered from an overabundance of female teachers who could not "secure from the young men all the intellectual work of which they are capable," nor "give them a manly development."  

With the report of a Royal Prussian Industrial Commission, which visited the United States for six weeks in 1904, foreign commentators seemed to be unanimous in their criticism of women teachers. While the Commission granted that there were moral benefits to be gained by mixing the sexes in coeducational classrooms, it declared that "the excessive number of women in the school service" was a principal defect in the quality of education offered to boys.  

It is not surprising that the Europeans found much to dislike in American coeducational schools, because the French and Prussian commissions came to the United States to investigate an educational experiment their own countrymen were loath to undertake. In many ways, therefore, their final reports served to justify the existing practice of their national school systems. According to historian James Albisetti, in France and Prussia women comprised a
relatively small percentage of the elementary teaching force, and boys and girls were usually schooled separately. In France, the Falloux Law of 1850 required communities with a population of 800 or more to establish separate schools for girls. In 1867, France’s Minister of Education lowered this limit to 500. As a result, by 1910 only 12.5% of French primary school pupils received their education in coeducational schools. Similarly, in Austria, Germany, and Prussia, separation of pupils by sex occurred in many cities. Although females comprised a much larger percentage of England’s teaching force, concern about women teaching older boys in coeducational schools became acute at precisely the time of the Mosely Commission’s visit to the United States.35

As might be expected, the negative commentary of Europeans stung some Americans to further criticism of the growing numbers of women teachers. In 1914, Admiral F. E. Chadwick sailed into the fray, coining the term, "the woman peril," to identify the source of the feminization of American boys. In Chadwick’s opinion,

The effect of [women teachers] has had so evil an effect upon the manhood of the country, on the qualities that go for making the masculine character, that it is more than full time to consider most seriously this great and vital question.36

According to Chadwick, women exerted an “unconsciously destructive influence on the masculine character of the boy.” To males rather than females, he argued, fell the
work of the world: the construction of steamships and railways, the command of armies and fleets, and so on. Because women were incapable of sympathy with the masculine realm of thought—a realm concerned with transportation, war, and finance—asking women to train prospective men was patently absurd. Writing on the eve of the First World War, Chadwick pointed admiringly to Prussia as an example of an advanced and highly civilized state, foremost in industrial and military development, which had attained such results because "no boy is ever, at any age, under woman tutelage."37

Chadwick's volley did not go unchallenged in the educational press. Florence Hewitt, a high-school teacher from Portsmouth, New Hampshire, responded with a critique of the admiral's logic. If all the boys have been tainted, she wondered, where would schools find "un-feminized" male teachers?38 Laura L. Runyon of the normal school at Warrensburg, Missouri, argued that Chadwick's statements were absurd in light of the fact that "shipbuilding, railroading---by his definition, masculine concerns"---were more vigorous than ever. Runyon suggested that further inquiry might reveal that the actual builders of the nation had received their schooling at the hands of female teachers, "while the men who cared nothing for public affairs had had men teachers."39 Of course, Chadwick had his share of supporters as well. Leonard Passano of the Massachusetts Institute of Technology wrote that "Admiral
Chadwick's...views are held by many who are interested in the education of boys." According to Passano, "Dissatisfaction with the employment of women teachers for boys...is now widespread."40

The debate continued to rage in spite of published statistical evidence indicating that the proportion of women teachers had actually little or no impact on the enrollments of boys in high schools. In 1909, the conservative educational psychologist Edward L. Thorndike conducted a study to discover whether "the ratio of boys to girls in high schools...can be largely increased by increasing the percentage of men teachers in these schools." Based upon a statistical analysis of data collected by the United States Commissioner of Education, Thorndike concluded that "the addition of men teachers has made very little difference, and very likely none at all, in the proportion of male students." In cases where he found a very slight correlation between male graduation rates and teacher gender, Thorndike hypothesized that such correlation could be explained by the addition of studies specialized for the sexes, such as manual training and domestic science, studies almost exclusively taught by instructors of the same sex as the students they served.41

Survey statistics published by the United States Bureau of Education supported Thorndike's conclusions (see Table 2). The data reveal that the growing percentage of women teachers from 1890 to 1920 was not accompanied by a growing
increase in the percentages of public high-school female students and female graduates. Nevertheless, in spite of Thorndike's study and evidence published elsewhere, opponents of women teachers continued to find a ready audience for their views in educational journals and popular magazines.

Table 2

Sex Ratios of Teachers and Students in Public High Schools, 1890-1920

<table>
<thead>
<tr>
<th>Year</th>
<th>Women/Teachers (% of whole)</th>
<th>Female/Students (% of whole)</th>
<th>Female/Graduates (% of whole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1890</td>
<td>58</td>
<td>57</td>
<td>65</td>
</tr>
<tr>
<td>1900</td>
<td>50</td>
<td>58</td>
<td>63</td>
</tr>
<tr>
<td>1910</td>
<td>55</td>
<td>56</td>
<td>61</td>
</tr>
<tr>
<td>1920</td>
<td>65</td>
<td>56</td>
<td>61</td>
</tr>
</tbody>
</table>


Why did more boys than girls drop out of school? Although critics targeted women as the cause, the most powerful influence on boys' lower enrollments and school performance lay in the social and economic conditions of the period. Almost all boys who left school prior to graduation did so in order to go to work. The industrialization of the northeastern and northcentral states had created new jobs in manufacturing and commerce, many of which paid higher wages than could be earned by schoolteachers. In the West, the University of Colorado experienced difficulty retaining its male students during the late nineteenth century, when
cowboys could earn as much as $100 per hour, and the
goldfields lured away young men hoping to strike it rich.42

Girls stayed in school longer because employment
opportunities open to them before the First World War were
less gainful than those available to boys, and because
marriage, the most common career for women, had to be
deferred until a young man could support a wife. A 1911-12
study of girls' employment opportunities found little or no
difference in the occupations open to the girls who
graduated from school at 14 years (after eighth grade) and
those who left school before graduating. Aside from
positions in domestic service, when they entered the
workforce, such girls could expect to find low-paying jobs
as bundle girls or sales girls in department stores, as
seamstresses, or as low-level factory workers.43

Another reason girls remained in school, especially
through to high-school graduation, was to obtain the
education necessary for such occupations as teaching or
nursing. Historian Alice Kessler-Harris argues that
teachers and nurses accounted for three-fourths of the new
professional women by 1920.44 In contrast to domestic
service or factory work, schoolteaching afforded young
working-class women the opportunity to increase their social
status. In a study of the enrollment patterns of working-
class students, John Rury discovered that greater numbers of
working-class girls than working-class boys continued in
school. David Tyack and Elizabeth Hansot have shown that
the pro-female disparity in enrollments between the sexes was even greater for African Americans than for whites (see Table 3). They conclude that more African American girls than boys attended high school in order to prepare for "what was becoming a chiefly female occupation--teaching."45

Table 3
Female High-School Students by Race, 1898-1928

<table>
<thead>
<tr>
<th></th>
<th>White (%)</th>
<th>African-American (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1898</td>
<td>57.8</td>
<td>68.1</td>
</tr>
<tr>
<td>1908</td>
<td>57.4</td>
<td>66.0</td>
</tr>
<tr>
<td>1918</td>
<td>57.0</td>
<td>67.9</td>
</tr>
<tr>
<td>1928</td>
<td>51.6</td>
<td>62.0</td>
</tr>
</tbody>
</table>


In addition to the expressed concern over boys' low enrollments, another important factor in the evident campaign against female teachers was the fact that increasing numbers of women competed with men for administrative positions and offices in professional associations. When Ella Flagg Young became superintendent of the Chicago public schools in 1909, she undoubtedly unnerved male educators with her confident prediction that women would eventually rule the schools of every city:

Women are destined to rule the schools of every city. I look for a majority of big cities to follow the lead of Chicago in choosing a woman for superintendent. In the near future we shall have more women than men in executive charge of the vast educational system.46
By 1911, this prediction seemed to be coming true. The Journal of Education reported that educational authorities in Omaha, Nebraska had promoted Belle Ryan to assistant superintendent, and Kate McHugh to the principalship of the high school; additionally, Edith Lathrop, superintendent of Clay county, had been elected president of the State Teachers' Association. Noting such trends, writer Earl Barnes, in an article entitled, "The Feminizing of Culture," stated that "even in supervisory positions, there are more women than men in the large centers of population." According to Barnes, "these figures justify us in saying that women have established a monopoly of education in the United States, except in the higher institutions." In an article entitled "The Monopolizing Woman Teacher," published the same year, educator Charles W. Bardeen warned male administrators that an army of women stood ready to drive them from their preserve and create completely female educational institutions. "My article," said Bardeen, "is not a protest; it is a recognition of the inevitable."

Potentially more disturbing to male educators, women also began to press local school authorities for salary increases. In 1906, Grace Strachan, district superintendent in Brooklyn, organized New York City's women teachers in a campaign for equal pay; the city's mayor signed the law mandating equal pay on October 19, 1911. In the same year, the elementary teachers of Boston organized against the "'croakers,' the 'not-yeters,' and the 'anti-womeners'" and
won legislative approval of a $1,000.00 salary for teachers of either sex.  

Women also began to exert a greater influence in such professional organizations as the National Education Association (N.E.A.). After a majority of women teachers conspired to nominate Young from the floor and she was elected as the first female president of the N.E.A. in 1911, Charles W. Bardeen stated sourly that the women took "the bit in their teeth and ran away, smashing the carriage."  

The backlash described above, which found its overt expression in educational journals and popular magazines, began to have a visible effect on the policy decisions of the men who created several new professional organizations in the early twentieth century. Among these new professional organizations, as we shall see, were three that had a decided influence on the career aspirations and attainments of women seeking to become science educators.

**Shutting Out the Women**

One way that male educators sought to counteract the newly-named "woman peril" was to restrict the extent of women's influence by creating professional organizations that barred females from membership. Perhaps the first, and most important such organization was Phi Delta Kappa. Phi Delta Kappa was founded in 1910 as a national professional fraternity committed to the scientific study of education. As such, the fraternity was an outgrowth of what contemporaries commonly called the "scientific movement in
education," a scholarly trend, originating with the development of mental tests around 1890, to apply experimental methods to the solution of educational problems.52

The bylaws of Phi Delta Kappa limited membership to white male graduate and undergraduate students. In the words of the fraternity's National Constitution, "Only white males of good character shall be eligible to membership in this fraternity." Members were chosen from the ranks of students at the more prestigious universities; graduates of two-year normal schools were barred unless they had later matriculated at a school of education associated with a university. Women were not eligible for membership until after the Second World War.53

The fraternity had many of the characteristics of a secret order, which may have contributed to its broad appeal among white males during a period when many prestigious schools erected formal and social barriers to Jews, African-Americans, Catholics, and immigrants.54 Members were selected by secret ballot and subsequently inducted through a mysterious initiation ritual. According to L. Vernon Bowyer of the Board of Education of St. Louis, Missouri, when potential members refused membership, they usually did so "because of religious scruples against belonging to any secret order."55

Many educators later to become prominent joined Phi Delta Kappa, drawn to the organization either because of its
exclusive nature or for the professional prestige that membership in the fraternity conferred. By 1922, the fraternity boasted a membership of more than 4,500 in twenty-six of the leading universities of the country. In that year, professor William S. Gray, Dean of the School of Education at the University of Chicago, wrote that new groups were rapidly forming:

With increasing frequency we are receiving information from various centers that groups of Phi Delta Kappa men are organizing such associations.56

Only eight years later, the organization included 82 presidents of universities and colleges and 76 presidents of teachers colleges and normal schools among its 12,636 members. The 1930 Phi Delta Kappa directory included the names of such eminent educational leaders as the philosopher John Dewey, psychologist Edward L. Thorndike, Ellwood Cubberley of Stanford, Elmer Ellsworth Brown, Chancellor of New York University (formerly the United States Commissioner of Education), Charles Hubbard Judd of the University of Chicago, and George S. Counts and Otis Caldwell of Teachers College, Columbia.57 According to Bowyer, an invitation to join Phi Delta Kappa was "such a distinct honor...that no one has ever declined the invitation to join except for religious reasons."58

One goal of the fraternity was to boost male enrollments in departments, schools, and colleges of
education at both the undergraduate and graduate levels. At the fraternity's national council meetings it was apparently usual for representatives from various universities to present their institutions' enrollment data for the purpose of demonstrating that their fraternal activities had boosted male enrollments. In 1923, George L.B. Fraser of the University of Chicago wrote to William S. Gray, assuring him that Chicago's enrollment data would make "a substantial showing" at the next council meeting:

I am proud to quote to you the figures...the increase is great. Similar increase was shown in the men graduating a year ago and this past spring--jumping from 14 to 30.59

In their efforts to increase male enrollments and graduation rates, fraternity members who held faculty positions wrote to each other on behalf of male students, asking for assistance and mentorship. For instance, W.H. Burton, Director of the Training School of Winona State Teachers College wrote such a letter to William S. Gray:

This will introduce to you Mr. John W. Goddard, the young man of whom I wrote you some time ago...Both Mr. Goddard and myself will appreciate very much anything you can do in assisting him to find his way about [at Chicago] and in planning his work.60

One critical way the fraternity worked to ensure an increase in male enrollment was to help young men find the most attractive and career-promising employment after graduation. This effort was aided by the fact that males

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had long been the preferred candidates well before the fraternity was founded; the deans of various universities and normal schools frequently wrote to each other asking for qualified male candidates to fill vacant positions among their faculty. However, before the founding of the fraternity, faculty members often also recommended women when no qualified male candidates were available. For instance, in 1907 R. H. Jesse of the University of Missouri, Columbia, wrote to Nathaniel Butler, then Director of the School of Education at the University of Chicago. Jesse was clear in his desire to hire for the position of dean "the right kind of man...one of little or no experience because we cannot pay enough to attract an older and more experienced teacher." In response, Butler wrote that the only candidates he and others on the faculty deemed qualified were women:

None of us seem to have been able to make any pertinent suggestion to you in regard to a successor for Professor Hill...if you have any positions that could be filled by women, I should like to recommend Miss Grace Lyman, who is a very strong woman, well known to the Graduate Department of this University, and also to Miss Lola Maria Harmon, who is now at Alexandria, Missouri, and who has considerable ability in pedagogical subjects.

After 1910, members of Phi Delta Kappa exerted an increased effort to find and place men, rather than women, on the faculties of universities, normal schools, and secondary schools. Women were still deemed suitable for such sex-typed positions as instructors of home economics or
as instructors in primary departments, but men were the preferred candidates for all other faculty positions. A letter from Charles H. Judd, Director of the School of Education, to William S. Gray, the Dean, illustrates this. Both men were members of Phi Delta Kappa:

I suggest that you go up to Teachers College [Columbia University] if you have time and see whether they have any promising young men. If you find anybody that you want, go ahead with the appointment...We have an item of $3,500 in the budget for Home Economics and I will recommend Miss Coon as soon as I get the data from you or from her.63

Phi Delta Kappa served the interests of established professionals as well as younger male students. By arranging its meetings in conjunction with several other highly influential organizations, the fraternity increased the likelihood that its members would be able to form important connections with professionals in different organizations and fields. Thus, Phi Delta Kappa arranged for its members to meet on the occasion of the annual meeting of the NEA, its Department of Superintendence, and the American Association for the Advancement of Science. In 1915, the fraternity's National Council created the National News Letter of Phi Delta Kappa, renamed as The Phi Delta Kappan in 1916. This journal continues today as one of the most influential magazines in the field of education.64

At the University of Chicago, members of Phi Delta Kappa effectively barred women faculty members from

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important social gatherings at which they could have made contact with eminent professionals from other institutions. For example, in 1925 Charles H. Judd wrote to William S. Gray about a social event at Judd's house to which only men were invited:

On Thursday evening, August the 6th, I am asking the men on the faculty of the School of Education to come to my house quite informally at 8:00 for the purpose of meeting one another and especially the men from other institutions who are with us for this term.65

In their quest to secure support and career advancement for white males, the various chapters of Phi Delta Kappa were not above admitting members whose scholarship was minimal. At the same time, women and men of other races whose scholarship was of the highest quality were denied the kind of encouragement that was so crucial to a professional at the beginning of his or her career. That some members of the fraternity were becoming concerned about the minimal scholarship requirements of the organization is evident from a letter written by Dean M. E. Haggerty of the University of Minnesota's College of Education to William S. Gray. In his letter, Haggerty urged the development of scholarly standards for fraternity members. He also noted that the race requirements of Phi Delta Kappa had prevented his chapter from electing "a very capable and personally agreeable Filipino last year." Haggerty suggested that "with adequate scholastic requirements and a conservative method of election...the interests of the fraternity will be

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adequately safe-guarded against the intrusion of undesirable members of other races."

In spite of Haggerty's concern over academic standards, the barriers imposed by Phi Delta Kappa against women were maintained with equal force against African Americans and members of other minority groups. For example, as an African American, Horace Mann Bond was barred from joining Phi Delta Kappa when he was a graduate student at the University of Chicago during the late twenties. According to historian Woodie T. White, Charles H. Judd endeavored to discourage nonwhites from matriculating at his institution by trying to deny them financial aid, even in cases where they appeared qualified. In his biography of Mann, historian Wayne J. Urban noted that black students at the University of Chicago "did not have the easy relationships with fellow students that whites did." Without specific mention of Phi Delta Kappa activities on the Chicago campus, Urban described the situation there as one in which professional interactions and friendships between blacks and whites were distinctly limited.

The Role of Phi Delta Kappans in Science Education

In addition to their gate-keeping functions, several influential members of Phi Delta Kappa played key roles in charting new directions in science education. Their numbers included William L. Eikenberry, S. Ralph Powers, Gerald S. Craig, and Francis D. Curtis. Eikenberry, a well-known
science educator at the State Teachers College in Trenton, New Jersey, helped to found the National Association of Research in Science Teaching and served on the boards of such organizations as the American Science Teachers Association and the later National Science Teachers Association. Powers, of Teachers College, Columbia University, formed the Association for the Education of Teachers of Science and served as chairman of the National Society for the Study of Education's influential Committee on the Teaching of Science in 1932. Craig, who was Powers's doctoral student, became a professor of science education at Teachers College and gained a reputation as one of the major proponents behind the new reforms in science education. Throughout his career, Craig authored dozens of science textbooks and lectured before thousands of teachers in school districts across the country. Francis D. Curtis, of the University of Michigan, pioneered the dissemination of research studies in the field of science education through what became known as the "Curtis Digests."69

The role of Eikenberry, Powers, and Curtis in the founding of The National Association for Research in Science Teaching (N.A.R.S.T.) ensured the exclusion of women from leadership positions in that organization at its inception. Eikenberry and others established the N.A.R.S.T. in 1928 as a professional organization to promote the scientific study of science pedagogy. The first president was Eikenberry; Powers was secretary, and the executive committee consisted
of Curtis, Elliot R. Downing of the University of Chicago, and Harry A. Carpenter. The initial membership of this organization was determined by Eikenberry, who simply presented his colleagues with a list of 32 individuals whose scholarly attainments (or potential for scholarship) he deemed sufficiently distinguished to be considered for membership. Of these, 18 (56 percent) were members of Phi Delta Kappa. As might be expected, there were no women on this list.70

The prestige of the N.A.R.S.T. and its influence on science education is apparent in the names of those who published in its official journal: men (and more rarely, women) from such institutions as Teachers College, Columbia, the University of Chicago, and other leading colleges and universities. Initially, the designated journal of the N.A.R.S.T. was the General Science Quarterly; its name was changed to Science Education in 1929. Science Education continues to this day as one of the most important and widest-circulating journals in its field. Not surprisingly, Phi Delta Kappa members comprised a majority of the editorial board and associate editors throughout the 1920s and 1930s. For example, in 1928, the Chairman of the editorial board, Charles J. Pieper of New York University's School of Education was a fraternity member, as were 13 (62%) of the journal's 21 associate editors. Only one associate editor was a woman: Florence G. Billig, a graduate of Teachers College, Columbia, who held a position with the
Similarly, the Association for the Education of Teachers in Science (A.E.T.S.) was established by a self-appointed group of four Phi Delta Kappa men. This organization grew out of the visits of Powers to various science teacher-training institutions in the 1920s. Powers conceived of the idea of forming an association to bring together the work of these science-education institutions. The initial leadership of the association was in the hands of Powers, Eikenberry, Earl R. Glenn of the New Jersey State Teachers College at Montclair, and John C. Johnson of the State Teachers College, West Chester, Pennsylvania. The association held its first meeting in 1932. The A.E.T.S. endures today as an organization that sponsors educational conferences focusing on current issues in science education.71

Women Need Not Apply

The professionalization of science education created a new position in some teacher-training institutions: the professional science educator. During the late nineteenth century, those faculty members responsible for teaching science pedagogy and content had held undergraduate or graduate degrees in a scientific field. However, the proliferation of new professional organizations and journals, along with the development of specialized departments of science education in teacher-training institutions, created a demand for a new kind of doctorate:
the Ed.D. (doctorate in education) in science education. Teachers College, Columbia, instituted its first science education seminar for doctoral students in 1925; in 1934, the college inaugurated a Doctor of Education program in a newly formed department of science education.72

Thus, the development of departments of science education created new faculty positions in some institutions—positions to which women were not always welcome to apply. William Eikenberry made his views known in this regard, as evidenced by a letter from Victor Crowell Jr., of State Teachers' College, Trenton, New Jersey to E. Laurence Palmer of Cornell University:

We are adding a new member to our department for next year as you undoubtedly know. A Mr. Harp, a graduate student at Teachers College has been appointed. I was rather sorry that Miss Compton did not get a chance at it but Mr. Eikenberry preferred a man.73

During the 1930s, the economic depression in the United States made the job competition between men and women even more acute. Constraints on financial resources severely reduced the number of available positions in schools of education across the country. For example, in 1933, Phi Delta Kappan Clarence Pruitt, a graduate student from Teachers College, wrote to his college mentor Gerald S. Craig, that the Dean of the School of Education at the University of Alabama had informed him that it was "financially impossible to continue my department next
year." Pruitt asked Craig to let him know of any job opportunities in science education. He let it be known that he was also willing to consider a high-school position, because "I am more than interested...jobs are more than scarce." Given the economic climate of the depression period, it is reasonable to assume that established men in financially pressed schools of education, particularly those who were members of Phi Delta Kappa, would have done all they could to find positions for their male students and fraternal brothers.

An effort to replace departing female faculty with males continued throughout the decade of the 1930s. For example, in 1934 A. W. Miller, a New York school superintendent, wrote to Craig at Teachers College, Columbia, asking for male candidates to replace a departing female teacher. The teacher, Rose Wyler, had accepted a position on the faculty of Plattsburg Normal School in New York. She had recommended five candidates as successors, of whom four were female. Miller wanted a man, however, and he wrote to Craig in the hopes of broadening the list of qualified males: "If we could secure a man of the right caliber, we would look upon such a recommendation with favor."

A month later, Miller again wrote Craig reiterating his desire to replace Wyler with a man. Apparently Wyler had given it as her opinion that there were no qualified men available to succeed her. From Miller's letter to Craig, it
is apparent that he would even have preferred a man of limited experience to an outstanding female candidate:

I take it from Miss Wyler that there does not seem to be an outstanding man lying loose at the present time. If you know of a young man with a couple of years experience, who gives promise of developing into an outstanding person, I should be glad to hear of him.76

To some extent, the professional barriers erected against women by members of the education community were similar to the sorts of institutional barriers erected against women in other professional fields during this period. Medical schools set quotas on female students just after 1910, and hospitals reinforced the practice by refusing to accept female interns.77 During the 1930s, journalism schools also took measures to combat the "woman peril." The dean of the Journalism School of Syracuse University justified the use of quotas by holding up the horrific example of Wisconsin, which reportedly had been "almost destroyed...a few years ago when it allowed itself to be overrun with women."78 In physics, the eminent Professor Robert Millikan of the California Institute of Technology refused to hire women even as postdoctoral fellows. When he heard, in 1936, that President W.P. Few of Duke University had offered a position in his physics department to Hertha Sponer, a German refugee reputed to be the third greatest woman physicist of the time, Millikan wrote Few to express his opinion that a reputable physics department could only be created through the recruitment of
young men rather than women. 

Although gender discrimination in education echoed similar developments in other professions, there was an important difference. In education, to a far greater extent than in other fields, men rarely pretended to each other that they were raising academic standards by excluding women. In education, men seeking to fill new positions were often forced to choose between less qualified male candidates and more experienced females. In a letter to Superintendent Miller recommending a very inexperienced male candidate for the position of arithmetic and science instructor, Craig justified his action as follows:

You may be adverse to employing a young man with so little experience. Personally, I feel that at the present time some of our best possibilities are in this group. 

Ironically, the low wages paid to teachers, and men's greater range of employment opportunities, even during the Depression, meant that schools experienced difficulty retaining qualified males. Throughout the period of backlash against women teachers, some educators argued that the best and most competent men still were not attracted to teaching. According to the Honorable John L. Buchanan, a Virginia state congressman:

Many of the brightest Americans are attracted by business...[teaching] is in danger of falling into the hands of inferior men.
On the other hand, because their professional employment opportunities were restricted, teaching was often chosen as a career by bright, well-educated, and over-qualified women. "Among persons liberally educated," claimed Buchanan in 1889, "more women that men find employment as teachers in the public schools." In science, women were also often more qualified. A survey of public high-school science teachers conducted in 1916 concluded that the women teachers had more college preparation in their subjects than did the men.82

In some cases, the rejection of women for positions in departments of science education may have been due to the belief that female candidates were unduly sympathetic towards nature study. For, in addition to creating new professional networks in science education, such leaders as Eikenberry, Powers, and Curtis also developed a new agenda for science education; among its goals was the elimination of nature study from elementary school programs across the country. Because the association of women with nature study was so strong, it is worth briefly recounting here some aspects of that movement's demise.

The Repudiation of Nature Study

The professional network of science educators, initially dominated by such men as Powers, Eikenberry, and Curtis developed a new agenda for reforming science education in American schools. As shown in journal and educational yearbook articles published in the 1920s and early 1930s, this agenda included such goals as conducting
scientific research to determine the most effective pedagogy and content in science education, systematizing science curriculum through the development of textbooks to be used in elementary and intermediate schools, and making school science more relevant to students' presumed social needs and interests.83

S. Ralph Powers and Gerald S. Craig, Powers' graduate student at Teachers College, Columbia, took the lead in personally opposing the nature study movement. In contrast to earlier generations of scientists and educators who had targeted natural history as the science most suitable for young children, Powers and Craig argued that the curriculum should be balanced between the physical and life sciences. They also questioned the value of learning scientific principles directly from nature. Instead, they recommended the introduction of textbooks at the elementary level and the addition of the teacher-centered demonstration method in higher schools to replace ostensibly cumbersome individual student laboratory work. Much of their criticism of nature study centered on the overblown rhetoric of some of its advocates, expressions Powers liked to describe as "a blend of science and Romanticism."84

In 1927 Craig published what was to become a highly influential doctoral dissertation: Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School. The Horace Mann School was a model school connected with Teachers College, Columbia. In this

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dissertation, Craig described his procedures in developing a new course of study, termed "elementary science," to replace the older nature-study curriculum then in use. Because the Horace Mann School was a nationally known laboratory school, any significant changes in its educational program would have been closely watched by educators across the country. In fact, many educators already knew of Craig's curriculum work even before the dissertation was completed, because his research involved surveying prominent science educators in order to obtain their suggestions for an elementary science curriculum to replace nature study.85

The official repudiation of nature study by the new leaders in science education occurred in 1932 with the publication of the Thirty-First Yearbook of the National Society for the Study of Education (N.S.S.E.). This report was prepared by this influential society's Committee on the Teaching of Science, which included Powers as chairman, Curtis as vice-chairman, Craig, Elliot R. Downing of the University of Chicago, Charles J. Pieper of New York University, and Ralph K. Watkins of the University of Missouri. All of these men were members of Phi Delta Kappa. It is noteworthy that of the Yearbook's authors, only one was a woman: the same Florence G. Billig who had served as the lone woman associate editor of General Science Quarterly in 1928.

In this pivotal yearbook, Powers declared that "on account of the traditions associated with the name," the
Committee had dropped the term 'nature study' in its references to courses in science for the elementary school. Instead, the Committee endorsed a new name: "Science for the Elementary School." According to Powers, the Committee "sees a more adequate recognition of its point of view in some of the newly organized courses, which are commonly designated as 'Science for the Elementary School.'"\textsuperscript{86}

One immediate and far-reaching effect of the Thirty-First Yearbook was to arouse the commercial interest of educational publishers. In his section of the report, Craig argued that the science-education specialist could render assistance to the classroom teacher not only by developing new courses of study but by authoring textbooks. This was a significant departure from earlier pedagogical views, because one of nature study's central tenants had been the importance of studying nature directly from the field; virtually every nature-study handbook published during the heyday of the movement exhorted teachers to refrain from using textbooks to teach scientific principles. Instead, nature-study advocates approved the use of books only as supplementary resources to an instructional program based on direct observation.\textsuperscript{87} Craig, however, soundly rejected this view, stating that "Great emphasis upon Agassiz's advice to study nature, not books, as the essential method of nature study has been at times unfortunate."\textsuperscript{88}

Shortly after the publication of the Yearbook, the publishing company Ginn & Co. approached Craig about the
possibility of producing a textbook series in elementary science. Ginn & Co. was not the only publishing concern to seize the opportunity to produce textbooks; according to a pamphlet published by the company, the publication of the Thirty-First Yearbook motivated widespread curriculum and textbook development:

Courses of study were written and rewritten in many places to meet its recommendations. Publishers hastened to produce new series of textbooks.89

Certainly the most visible result in American schoolrooms of the influence of Craig and other reformers was to replace the direct, if perhaps incidental, study of natural phenomena with a systematized program of textbook study. Craig himself authored many series of science texts, all of which sold well. When he retired, the annual income produced by his textbook royalties was more than four times his salary as a full professor at Teachers College, Columbia.90

Throughout the following years, Craig taught his Teachers College students to oppose nature study wherever they found it. Years later, Robert Stollberg, one of Craig's former students who had accepted a position as professor of science education at San Francisco State College, wrote Craig to describe his institution as a hotbed of nature study. It is evident from Stollberg's letter that he remembered Craig as having been quite critical of the
Of course you know that this particular region is a very hot spot for Nature Study. Yes, we have courses which are brazenly called by that name and further more they are required of elementary teachers. In them the students learn about classification, preservation, nomenclature, and all those wicked wicked things you used to warn us about in class.91

The repudiation of nature study in the 1930s by the new leaders in science education must have made it extremely difficult for the female students of nature study's supporters to find employment. In one case, school superintendent A. W. Miller wrote to Craig in 1939 to ask his opinion of a female job candidate known to have been previously associated with nature-study methods. In his response, Craig expressed reservations because,

She has been under the tutelage of nature study enthusiasts for many years. She has come under the influence of the museums, and as you probably know, the museums of the country foster a type of teaching all their own.92

The association of women with nature study, coupled with the more general desire to hire men for new faculty positions, had an undoubtedly deleterious effect on women's career opportunities in science education. Although statistical data do not appear to have been collected on departments of science education specifically, the available data on faculties of teachers colleges and normal schools from 1900 to 1948 reveal that the numbers of female faculty
in such institutions indeed dropped after the First World War (see Table 4.)

Table 4
Percentage of Male and Female Faculty and Undergraduate Students in Teachers Colleges and Normal Schools, 1900-1948

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<td>65</td>
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The data presented in Table 4 depict several trends. First, the decade from 1900 to 1910 reveals a quite definite increase in the proportion of both female faculty and undergraduate students. It was this development that accelerated the creation of Phi Delta Kappa in 1910, as discussed above. Second, the data indicate a gradual shift to a male majority among the faculty and students from 1910 to 1948.

The gradual nature of this change is to be expected, particularly in the decades from 1910 to 1940. During the years of the First World War, members of Phi Delta Kappa could not have expected to have made rapid headway in increasing the proportion of men on their faculties, because
the events of the war often drew males away from such institutions. The Thirties would also have been a difficult period in which to alter the proportions of the sexes, because the economic depression during these years resulted in the retrenchment, rather than expansion, of many departments of science education. During this decade, the opportunity to replace women with men would have arisen only when new positions were created through faculty retirement or resignation.

The School of Education at the University of Chicago provides a case in point. When Colonel Francis Wayland Parker joined the newly organized School of Education in 1901, he brought with him 30 of the 36 teachers from Cook County Normal School, of whom a substantial number were women. However, in later years, as these women retired, they were either not replaced or their positions went to men. According to Geraldine Jončich Clifford and James W. Guthrie, the proportion of women on the Chicago faculty declined from a high of 22.5 percent in 1910 to 10.3 percent in 1940.

While women were losing to men in the competition for faculty positions in teachers colleges and normal schools, female students also came to comprise a smaller proportion of the undergraduate student body at such institutions after 1930. The number of female undergraduates reached a peak in 1929-30, with 124,878 students. By the following decade, the number of female undergraduates suffered a 35% decline.
only 81,714 female students were enrolled in 1947-48.96

One likely factor in the decline of female undergraduates in schools of education was the increased resistance of male administrators and faculty members to the hiring of women teachers in secondary schools. In fact, the effort to replace retiring female faculty with males had a visible impact on the proportion of the sexes in secondary school teaching positions. Here again, statistical data do not appear to have been collected on teachers of science specifically, but the data collected on the general population of public high-school teachers reveal a distinct increase in the proportion of men from 1920 to 1940 (see Table 5). In that period, there occurred a 31 percent increase in the proportion of male teachers in secondary schools.

Table 5

Percentage of Male and Female Teachers in Public High Schools, 1909-1940

<table>
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</table>


The repudiation of nature study, coupled with the general discrimination against women in science education,
almost certainly affected their university enrollments. It must have been a factor in the decline in women's science enrollments at Stanford University in California, for example. As at other California colleges and universities, the vast majority of Stanford female students studied science in order to become science and nature-study teachers. Stanford was one of the reasons that the San Francisco Bay Area was long considered a "hot spot for nature study." Stanford's president David Starr Jordan was a close personal friend of Anna and Henry Comstock; many of the university's graduates went on to become well-known nature-study leaders.97

The years after the First World War saw a decline in Stanford women's science enrollments in every subject, as shown below in Table 6; only geology showed no change—and that was because no women received a degree in this subject during the years represented in the table. Stanford women's relatively small and declining share of the student body makes all the more striking their earlier dominance, in 1907 and 1912, of the sciences traditionally associated with nature study: entomology, botany, and zoology. The University's newly organized School of Biology awarded its first degrees in the 1923-24 school year, and for the first several years, the proportion of young women receiving degrees in biology greatly exceeded the proportion of women in the overall student body. In 1932, however, only one of 21 graduates was a woman.
Table 6
Percentage of B.A. Degrees Conferred on Women in Selected Fields, Stanford University, 1892-1932

<table>
<thead>
<tr>
<th>females as % of student body</th>
<th>Entomology</th>
<th>Botany</th>
<th>Physiology</th>
<th>Zoology</th>
<th>Physics</th>
<th>Chemistry</th>
<th>Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1892</td>
<td>25</td>
<td>0</td>
<td>100</td>
<td>50</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1897</td>
<td>37</td>
<td>0</td>
<td>100</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>1902</td>
<td>35</td>
<td>--</td>
<td>--</td>
<td>40</td>
<td>40</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>1907</td>
<td>30</td>
<td>67</td>
<td>100</td>
<td>10</td>
<td>50</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td>1912</td>
<td>28</td>
<td>25</td>
<td>67</td>
<td>20</td>
<td>75</td>
<td>100</td>
<td>65</td>
</tr>
<tr>
<td>1917</td>
<td>23</td>
<td>33</td>
<td>50</td>
<td>14</td>
<td>33</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>1922</td>
<td>14</td>
<td>0</td>
<td>50</td>
<td>14</td>
<td>36</td>
<td>--</td>
<td>9</td>
</tr>
<tr>
<td>1927</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>1932</td>
<td>13</td>
<td>--</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>7</td>
</tr>
</tbody>
</table>

Source: Data compiled from the 1st, 6th, 11th, 16th, 21st, 26th, 31st, 36th, and 41st volumes of The Leland Stanford Junior University Annual Register (Palo Alto, California: University Press).

The years after the First World War at Stanford, as elsewhere throughout the nation, witnessed a large increase in the male proportion of the student body as veterans returned home to take up their studies. According to a historian Linda Winthrop Peterson, returning Stanford students "came home...to a campus that was, in large part, controlled by young women." This state of affairs did not last long. Growing numbers of young men returned to fill classrooms, encouraged by male mentors who provided support during the undergraduate years and assistance in finding employment afterwards.

The events of the post-War years undoubtedly led many young women to conclude that perhaps schoolteaching was not, after all, women's true profession. Certainly it was
becoming painfully clear that women were no longer very welcome as colleagues in science education.

Conclusion

Previously published studies of the political and cultural backlash against women teachers have linked this development with changes in the curricula of elementary and secondary schools, the rise of vocationalism, or the establishment of home economics programs in American secondary schools. This study contributes to previous research by relating the reactions against women educators to the development of such professional organizations as Phi Delta Kappa and the National Association for Research in Science Teaching.

By investigating the effects of discrimination against women in faculty hiring, the study identifies an important and hitherto overlooked factor in the demise of science as a field of fruitful endeavor for women. During the late nineteenth-century, and throughout the heyday of the nature-study movement, women had filled college science courses in their preparation to become science teachers. By the 1930s, however, the efforts of male science educators to fill faculty positions with men were successful, and this career path slowly and steadily closed to women.

By focusing primarily on developments within the field of education, this study has not detailed additional factors that contributed to the decline of science as a female
interest. This is the task of the following chapter. As we shall see, several new career paths opened to young women during this same period, paths on which women encountered far less resistance than they now faced in science.

Notes


(2) For a discussion of the role of the land-grant University of California in preparing women to teach at the turn of the century, see Geraldine Joncich Clifford, "Equally in View: The University of California, Its Women, and the Schools, p. 46ff; 52; 92ff. Clifford argues that the growth of 19th-century public schooling, and its resultant demand for teachers, motivated the entry of women to American colleges and universities just after the Civil War.


(4) Quoted in Annual Report of the State Superintendent of Public Instruction of the State of Wisconsin (Madison, Atwood & Rublee, 1858), 157.

(5) Ibid., 119. The superintendent quoted Barnard on page 157.


(8) Ibid., 32.


(17) F. E. DeFoe and C.N. Thurber, "Where are All the High School Boys?" in School Review 8 (1900): 240.

(18) Enrollment data for trigonometry were not published until 1900. In that year, trigonometry was the only subject in which boys constituted a majority. Still, the subject attracted a pitiful number of students, as fewer than three percent of males enrolled during the last four years of high school. See John Latimer, What's Happened to Our High

(19) Latimer's data are reported as the percentage of each sex enrolled. Using the percentages and overall enrollment figures, I calculated the enrollments in each subject.


(22) Harris is quoted in Tyack and Hansot, Learning Together, 158.


(31) Caroline Fairfield Corbin, Socialism and Christianity With Reference to the Woman Question (Chicago, 1905), 31. See also Butcher, Education for Equality, 62ff.


(33) Quoted in Maxwell, "Should the Education of Boys and Girls Differ?" 111.

(34) William Hailmann, "German View of American Education


(37) Ibid., 11506.


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(53) Quoted in Phi Delta Kappa Directory, 1931 (Fulton, Missouri: Ovid Bell Press, 1931), 84. The directory includes the entire constitution and bylaws of the fraternity; "Guide to the College of Education Records 1900-1926," The University of Chicago Library Department of Special Collections, 1980, 8; Phi Delta Kappa Directory, 1931, 17-73.


(56) William S. Gray to A. C. Davis, Oct. 26, 1922, file 6, box 34, CER, UCSC.

(57) These men are listed as members in the Phi Delta Kappa Directory (Fulton, Missouri: The Ovid Bell Press, 1931), 66.


(59) George L.B. Fraser to W. S. Gray, Dec. 9, 1923, file 8, box 34, CER, UCSC.

(60) W. H. Burton to W. S. Gray, July 21, 1922, file 5, box 34, CER, UCSC.

(61) R. H. Jesse to Nathaniel Butler, May 28, 1907, file 9, box 3, CER, UCSC.

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(62) Nathaniel Butler to R. H. Jesse, July 27, 1907, file 9, box 3, CER, UCSC.

(63) Charles H. Judd to William S. Gray, March 15, 1926, file 7, box 32, CER, UCSC.


(65) Charles H. Judd to Dean William S. Gray, Aug. 4, 1925, file 7, box 32, CER, UCSC.

(66) Dean M. E. Haggerty to Dean W. S. Gray, Oct. 6, 1923, file 10, box 34, CER, UCSC.


(70) Willard J. Jacobson, "The First Meeting of the National Association for Research in Science Teaching," paper presented at N.A.R.S.T., Cincinnati, Ohio (March 23, 1977), box 1, Gerald S. Craig Papers, unprocessed additions, Wisconsin State Historical Society (hereafter cited as WSHS). I identified members as Phi Delta Kappans if their names were included as such in the Phi Delta Kappa Directory, 1931.

(71) Typescript entitled "The Early Years of A.E.T.S.," box 1, Craig Papers, unprocessed additions, WSHS. Glenn and Johnson are listed as members in Phi Delta Kappa Directory, 1931, 182; 216.

(72) Willard J. Jacobson, "A History of the Department of Science Education, Teachers College, Columbia University," paper presented as part of the session "Illuminating the Present from the Past: The History of Science Education" at the 26th National Convention of the National Science Teachers Association (Washington, D.C., April 7, 1978), box 1, Craig Papers, unprocessed additions, WSHS.

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(74) Clarence Pruitt to Craig, April 10, 1933, file 1, box 1, Craig Papers, WSHS. Pruitt is listed as a member of Phi Delta Kappa in Phi Delta Kappa Directory, 1931, 281.

(75) A. W. Miller to Gerald S. Craig, March 23, 1934, file 9, box 5, Craig Papers, WSHS.

(76) A. W. Miller to Craig, April 12, 1934, file 9, box 5, Craig Papers, WSHS.


(79) For a discussion of this case, see Margaret Rossiter, Women Scientists in America: Struggles and Strategies to 1940 (Baltimore: The Johns Hopkins University Press, 1982), 190-93.

(80) Craig to A.W. Miller, May 19, 1936, file 9, box 5, Craig Papers, WSHS.


(84) Powers, "Preface," in Orra Underhill, The Origins and

(85) Gerald S. Craig, Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School (New York: Teachers' College, 1927).


(89) Gerald S. Craig: A Man and A Program (Ginn & Co., undated), 6, box 23, in Craig Papers, unprocessed additions, WSHS.

(90) "Ginn & Co. Publishers Annual Royalty Statement to Nov. 30, 1961" in Craig Papers, box 2, unprocessed additions, WSHS. As of 1958, the average yearly royalty payment to Craig during the previous five years was $38,689.33. In 1955, Craig's base salary as a full professor at Teachers College was $8,000.00. See letter from the President of Teachers College to Craig, Feb. 15, 1955, file entitled "Teaching Appointments" in ibid.

(91) Robert Stollberg to Craig, Jan. 12, 1949, file 2, box 3, Craig Papers, WSHS. I have added the underlining for emphasis.

(92) Craig to A. W. Miller, 1939, file 9, box 5, Craig Papers, WSHS.
The precipitous drop in female share during this period is undoubtedly caused by the effects of the G.I. Bill on college enrollments and veterans' preference policies in many fields, including teaching.

"Will Secede from the Normal School," newsclipping dated June 17, 1899, Scrapbook 12, Francis Wayland Parker Scrapbooks, UCSC.


Chapter 8
Giving Up Science and Mathematics

Introduction

Working in different fields, a number of historians interested in understanding the demise of science as a girls' subject in the late nineteenth century have proposed developments likely to have contributed to this phenomenon. Focusing on England, a recent study of women's scientific interests concludes that middle- and upper-class women abandoned the sciences in favor of the classics near the end of the nineteenth century. According to historian Patricia Phillips, as English women sought an educational program equal to that of men, "they resigned the scientific identity that had been theirs since the seventeenth century." In part, this was due to the well-meaning attempts of reformers to improve the quality of girls' schools by increasing the quota of classics offered there.1 Concentrating on the United States, several scholars studying American educational history have identified the late-nineteenth century vocational movement as an important factor in girls' declining enrollments in secondary-school science courses.2

This recent scholarship is suggestive of a significant relation between social class and girls' interests and opportunities in science education. To what extent did American middle- and upper-class women, like their English sisters, relinquish scientific study in favor of the
classics? And what effects did changes in curriculum and policy undertaken during the vocational movement have on the science studies of working-class girls and their more affluent and privileged peers?

In order to understand the degree to which conditions may have occurred in the United States comparable to those in Great Britain, the following discussion begins by analyzing the rise of the classics in early nineteenth-century female secondary schools and colleges.

Girls Take Up the Classics

During the seventeenth and eighteenth centuries, generations of middle- and upper-class American schoolboys in Latin grammar schools studied an unchanging curriculum devoted almost solely to Latin and Greek. Their schoolmasters and parents supported this educational program because they viewed the classics as the preferred means of providing a rigorous moral and intellectual training. It was a commonly held view that the best minds were those whose faculties had been strengthened through years of classical application. The female mind, on the other hand, had long been believed deficient in rational powers. Many seventeenth and eighteenth-century educators viewed girls as mentally unfit by nature for the expenditure of effort required to study the classics.3

Gradually, almost imperceptibly, at the dawn of the nineteenth century some schools providing a form of secondary education for girls---female seminaries and
academies, boarding schools, ladies' select schools, and so on---began to break with this traditional view by including Latin in their curricula. The turn to Latin in girls' schools occurred in both northern and southern states, as evidenced by local newspaper advertisements and school catalogs. In Massachusetts, Westford Academy included Latin and Greek in its curriculum in 1792. The school was open to students of any nationality, age, or sex who could "read in the Bible readily without spelling."⁴ In North Carolina, girls' schools increasingly mentioned Latin after 1810 (see Table 1).

Table 1
Percentage of North Carolina Female Secondary Schools Advertising Latin, 1800-1830

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800-1809</td>
<td>0%</td>
</tr>
<tr>
<td>(6 schools)</td>
<td></td>
</tr>
<tr>
<td>1810-1819</td>
<td>17%</td>
</tr>
<tr>
<td>(12 schools)</td>
<td></td>
</tr>
<tr>
<td>1820-1830</td>
<td>21%</td>
</tr>
<tr>
<td>(24 schools)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Data compiled from newspaper advertisements included in North Carolina Schools and Academies, ed. Coon.

In Connecticut, Mrs. Grovesnor and Mrs. Sheldon's School for Young Ladies stated in an 1820 advertisement that "the Latin language, geography, history, painting, needlework, and music will be taught throughout the year....pupils will also be instructed in botany during the summer, and chemistry in the winter."⁵ Catharine and Mary Beecher's school in

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Hartford advertised "Latin grammar, Virgil [and] Historiae Gracae" in 1823, as did a number of other New England institutions.6

Initially, girls' schools offered Latin as an elective subject. In North Carolina, the female department of North Carolina's Raleigh Academy included Latin, French, music, painting, and needlework as electives in its course of study in 1811, as did New Bern Academy in 1823.7 When Mary Lyon established Mount Holyoke Female Seminary in 1837, she offered students the option of studying Latin, and according to a former student, by "1840, about one-fourth of the pupils were voluntarily pursuing it."8

Although evidence is sketchy, Latin appears to have been more prevalent in some areas of the north than in the middle and southern states. As shown in Table 2, 42 percent of a sample of 24 girls' schools in Connecticut, Massachusetts, New York, and Maryland included Latin in their advertised courses of study from 1820 to 1842, in contrast to 21% in North Carolina from 1820 to 1830, and even smaller percentages in Virginia and Pennsylvania.

In her history of women's education in the antebellum South, however, historian Christie Farnham claims that Latin appeared more frequently in southern girls' schools than in northern institutions. Farnham argues that the divergent values of North and South were reflected in the attitudes of the two regions towards women's study of the classics. In her view, the democratization of the North
Table 2
Percentage of Female Secondary Schools Offering Latin Before 1840 in Selected States

<table>
<thead>
<tr>
<th>Dates</th>
<th>Sample Size</th>
<th>States</th>
<th>Number and Percentage of Schools Offering Latin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1835-1838</td>
<td>31</td>
<td>Virginia</td>
<td>4 (13%)</td>
</tr>
<tr>
<td>1750-1829</td>
<td>36</td>
<td>Pennsylvania</td>
<td>5 (14%)</td>
</tr>
<tr>
<td>1820-1830</td>
<td>24</td>
<td>North Carolina</td>
<td>5 (21%)</td>
</tr>
<tr>
<td>1820-1842</td>
<td>24</td>
<td>Massachusetts; Connecticut; New York; Maryland</td>
<td>10 (42%)</td>
</tr>
</tbody>
</table>


favored a more utilitarian approach to education, whereas the elitist nature of southern culture favored the study of Latin and Greek. Farnham bases her conclusion on a small sample of five North Carolina female seminaries; clearly, the evidence provided in Table 2 does not support her conclusion. Based on the sources used in this study, one might argue with equal plausibility that the social conservatism of the South slowed the introduction of Latin into southern girls' schools.13
Why did authorities in both northern and southern girls' schools begin to include Latin in their courses of study? Some educators promoted the study of Latin for its presumed ability to discipline the mind or to develop habits of patience and perseverance. "How much patience is needed to get one lesson in Latin," asserted educator John Todd in 1854, "or to make a single good recitation in algebra!" However, the most probable reason for adding Latin to the curriculum was that, in every region of the country, educators viewed the subject as a vehicle for enhancing their schools' status and prestige and as a means of making their institutions more comparable to male academies. In 1838, the well-known educator Almira Hart Lincoln Phelps proclaimed that the object of her school at West Chester, Pennsylvania was "to furnish females with the means of acquiring a liberal education, coinciding, as far as the varying conditions of the two sexes will admit, with a collegiate course for the other sex." Pursuing a so-called collegiate course for girls, meant, of course, introducing some study of the classics.

An important social development fueling the rise of Latin in girls' private schools and in the new coeducational public high schools was the opening of new institutions for women bearing the designation of "college." Some scholars have dismissed these early attempts at post-secondary education, viewing them as colleges in name only. Nevertheless, as the following discussion will show, such
institutions had an overlooked and important influence on the curricula of girls' secondary schools aiming to prepare students to meet the new collegiate entrance requirements.

The first experiment in women's collegiate education in the United States took place in the South, with the chartering of Georgia Female College in 1836, an institution authorized to "confer all such honors, degrees, and licenses as are usually conferred in colleges or universities." The college opened on January 7, 1839. "The project is novel," wrote George F. Pierce, the College's first president, "It stands out on the map of the world's history alone -- a magnificent example of public spirit and Catholic feeling -- of devotion to literature, and of zeal for Female Education." As a new educational experiment, the college was undoubtedly the subject of some criticism, not only from those who ridiculed the notion of higher education for women, but from critics who questioned the rigor and quality of its studies. Traditionally, the presence of the classics in the entrance requirements served as a marker of an institution's relative quality. Because Georgia Female College did not require a demonstration of classical knowledge for admission, contemporaries judged its academic standards to be relatively low. Pierce himself felt called upon to explain the college's admission policy, admitting that "the standard of admission especially is reduced so low as to present an incongruity between the high character of a college...and the requisitions laid down in our plan, as
published in the catalog."¹⁹ In defending the policy, however, Pierce argued that the low standards were a financial necessity, since elevating them would "diminish the number of scholars, and consequently, the receipts from tuition."²⁰

Despite fears that high admission standards might limit the number of qualified scholars, it was not long before other newly-organized institutions designated as women's colleges began adding the classics to their entrance requirements. For example, in 1842, Wesleyan Female College at Cincinnati, Ohio, required Latin grammar, Latin reader, the Commentaries of Caesar, and Greek grammar and reader. Established in 1853, the Wesleyan Female College at Delaware, Ohio, offered students the choice of either a scientific or classical four-year course. Entrance requirements for the classical course required some knowledge of Latin and Greek: "first and second books."²¹

The admission requirements of Mary Sharp College, which opened in 1851 at Winchester, Tennessee, specified knowledge of Greek grammar, Testament, Latin grammar, Virgil, Cicero, and Horace. When Vassar opened in 1861, its entrance requirements included Latin grammar, syntax, Latin prose, two books of the Commentaries of Caesar, two orations of Cicero, French, and several modern subjects. Finally, a landmark of sorts was reached when Smith College opened in 1875. Its admission standards, heavily weighted with the classics, matched those of Amherst and Harvard.²²

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During the 1830s, some critics lampooned the presumed shallowness of the studies offered in the newly-founded women's colleges. For example, in 1831, the Raleigh Register carried a mock advertisement for a "Refined Female College," headed by "Madame Walk-in-the-Water." Its course offerings included "balling and gadding in the streets," "talking idly, and dressing ridiculously," and "lacing yourself into the shape of an hourglass."23

However, with the advent of classical studies in the entrance requirements and curricula of women's colleges, such criticism abated. The 1855 catalog of Alabama's Judson Female Institute described its curriculum, which included Latin, as "substantially, a College course." The significance of Latin in Judson's educational program was not lost on the Rev. A. J. Battle, who proclaimed in his 1857 commencement address at Judson, "It is no longer doubted that [women are] endowed with an intellect, capable of indefinite expansion and improvement."24

Reflecting the shift towards the classics in the entrance requirements of women's colleges, the percentage of girls' schools offering Latin visibly increased during the rest of the century. Based on a sample of 162 girls' schools from twenty states, historian Thomas Woody reported that 47 percent provided instruction in Latin between 1749 and 1871. However, by including eighteenth-century schools in his sample, Woody's data may not accurately reflect the degree of increase of Latin in the curriculum after 1830. A
more representative picture of developments in the latter half of the century may be that reported by James Mulhern, who discovered that between 1830 and 1889, 72 percent of Pennsylvania girls' schools offered Latin.25

To a lesser extent, girls' schools began to offer Greek as well, although this subject lagged behind Latin in both male and female institutions throughout the century. For example, in Pennsylvania from 1750 to 1829, only 3 percent of girls' schools offered Greek, whereas 14 percent offered Latin. In later years, from 1830 to 1889, 37 percent of girls' schools offered Greek whereas 72 percent offered Latin. The greater emphasis on Latin in girls' schools may be explained by the fact that throughout this period, Greek was perceived as a prerequisite subject for those preparing to enter the ministry, a field largely closed to women.26

Taking up the classics required female students to devote a substantial proportion of their school hours to practicing Latin grammar and reading such authors as Caesar, Virgil, Cicero, and Xenophon. Such study could hardly be successfully undertaken without reducing attention to other subjects. In some cases, girls abandoned the study of the sciences to make room for the classics. For instance, when Swedish commentator Per Siljestrom visited Hartford (Connecticut) High School in the 1850s, he reported that the school had enacted a provision that girls might omit "etymology, the geography and history of the United States, natural philosophy, chemistry, and philosophy" and
substitute for them the study of Latin."\(^{27}\)

The importance of classical studies in American secondary schools surprised Siljestrom, who had expected to find a curricular emphasis on the sciences and other so-called practical subjects when he visited the United States at mid-century. Instead, he discovered that Latin and sometimes Greek were among "the more substantial accomplishments which form part of the higher education of women in America." In Siljestrom's opinion, this trend was unfortunate. Believing that it was not "of the least value either for woman or for man to possess a smattering of Greek or Latin," he recommended that Americans increase their offerings of such subjects as geometry and geometrical drawing, natural history, and manual arts.\(^{28}\)

Girls had an increased incentive to study the classics after the Civil War, however, when growing numbers of previously all-male colleges and universities began to open their doors to females. Without knowledge of Latin, young women could not obtain entrance to the prestigious collegiate courses in liberal arts colleges. Statistical data reveal that in liberal arts universities and colleges in 1872, women more often enrolled in scientific departments than in collegiate departments. In that year, the Commissioner of Education published statistics on 298 universities, colleges, and collegiate departments. Of these institutions, 59 (20 percent) enrolled students in a scientific, as well as a collegiate course. In institutions
that offered both a scientific and a collegiate department, more females chose to enroll in the scientific department (see Table 3).

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Collegiate Departments</th>
<th>Scientific Departments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>599 (41%)</td>
<td>878 (59%)</td>
</tr>
</tbody>
</table>


Several factors may have influenced women to enroll in scientific courses, where they studied such subjects as botany, physiology, chemistry, scientific illustration, or horticulture. One factor was the length of the course. Students not interested in a full four-year collegiate course often enrolled in the scientific course, where they might study for shorter periods of time. A second factor was the perceived practicality of the scientific course, which, in the absence of nearby normal schools, served to prepare students to assume teaching positions in secondary schools.

But most importantly, the entrance requirements of such institutions undoubtedly weighed heavily on women's enrollment decisions. In many cases, entrance to the collegiate department required knowledge of Latin, Greek, or both, subjects studied by a minority of girls in
secondary schools. For example, to gain admission to the College of Letters at the land-grant University of California in 1871, students had to pass an examination on Latin grammar, four books of Caesar, 6 books of Virgil, 6 orations of Cicero, Greek grammar, and Xenophon's Anabasis. On the other hand, admission to the scientific College of Arts required knowledge of subjects more familiar to girls: higher arithmetic, algebra to quadratic equations, geometry, English grammar, geography, and the history of the United States. In 1873, women comprised only 10 per cent of the freshmen students enrolled in the College of Letters, whereas they comprised 18 percent of freshmen enrolled in the College of Arts.

Middle-class women leaders anxious to elevate the status of female education were not pleased to discover that girls had difficulty meeting the entrance requirements of the traditional collegiate course. The scientific course, which usually substituted a modern language for Latin, was often considered terribly déclassé. Unlike their great-grandmothers, who had aspired to study the sciences as a means of attaining an acceptable form of cultural polish, late nineteenth-century women now set their sights on the liberal culture provided by classical study. The growing application of science and technology to business enterprises, and the resultant demand for mechanics, engineers, mining experts, and agricultural chemists, had noticeably shifted science's position in society. Although
the middle and upper classes still flocked to hear scientific lectures and read articles about the most recent discoveries, they no longer looked so favorably on such study for their daughters. After all, science courses in the new Land Grant Colleges and universities were increasingly filled with young men from the lower-middle, working, and farming classes eager to train for new jobs in the new agricultural experiment stations and in industry. Another mark of the inferiority of the scientific course was its relatively short duration, often requiring only two or three years of study, in contrast to the traditional four-year collegiate course.31

At the annual meeting of the New England Women's Club in 1873, members discussed with great interest recent efforts in certain private preparatory schools to make classical training available to girls. In its report, the Club noted with approval that not only were some girls' schools beginning to offer advanced classical training, but a few all-male preparatory schools had begun to admit girls for the purpose of studying the classics:

Chauncey Hall School [has] thrown its doors open to girls as freely as to boys, offering them the opportunity of obtaining the same thorough fitting for college--the Latin School in Roxbury has, we understand, this year taken the same onward step.32

Given the historical role of the classics in the education of gentlemen, girls met a surprising lack of
resistance when they began to invade this traditionally male domain. Ironically, this may be explained by the rising popularity of science among the more literate public during this period. The historian Frank Luther Mott has documented the enormous growth of American interest in science in the 1860s and 1870s as evidenced in general magazines and newspapers. According to Mott, articles on science typically ranked ahead of fiction, travel, and history-biography in popular magazines during these decades. Statistical records kept by the Astor Library, in New York, reveal that among the Astor's readers in 1872, scientific works had attained a popularity equal to that of general literature.33

Americans grew especially concerned to promote the study of science among boys. For example, Popular Science Monthly, first published in 1869, often included articles castigating schools for their lack of science courses and facilities. In 1872, the Monthly published an editorial critical of the narrow education available to boys:

> When a mother is ambitious that her son shall have a liberal education, and commits him to the accredited agencies, the question, is, "What will become of him?" It is notorious that a pupil can go through a course of so-called liberal study and graduate with honor at the highest institutions, in complete ignorance of science.34

The establishment of land-grant universities, agricultural experiment stations, and the increased need for engineers during these decades led many Americans to view
science from a new perspective. No longer largely the
domain of the interested amateur, the sciences appeared to
have been transformed into professional fields in which a
young man might actually be able to make a decent living.\textsuperscript{35}

At precisely the same time that growing numbers of boys
turned to the sciences, increasing numbers of girls began to
take up the classics, motivated by the desire to gain
entrance to the more socially prestigious collegiate course
in universities and colleges. Many late-nineteenth century
high schools offered at least two distinct courses of study:
the Classical or the Scientific; others offered such additional
courses as the Modern Languages and the English.\textsuperscript{36} During the
late-nineteenth century, the Office of Education collected
data on the numbers of students in private and public high
schools preparing for either a classical course in college
or for a scientific course in a college or scientific school
(see Table 4). The data reveal a distinctly opposite shift
in the curricula studied by the two sexes. In 1890, a
greater number and proportion of boys than girls studied a
classical curriculum, whereas in the scientific curriculum,
the number of girls exceeded that of boys, although the
proportion of girls was somewhat smaller. However, by
1910, the number and proportion of girls studying the
classical curriculum exceeded that of boys, and the number
and proportion of boys enrolled in the scientific curriculum
was four times greater than that of girls.
Table 4
Number and Percentage of Public and Private High-School Students by Sex in Grades 9-12 Preparing for One of Two Curricula in College or Scientific School, 1890-1910

<table>
<thead>
<tr>
<th></th>
<th>Classical Curriculum</th>
<th>Scientific Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>1890</td>
<td>8,084 (9.4%)</td>
<td>6,844 (5.9%)</td>
</tr>
<tr>
<td>1895</td>
<td>12,816 (8.9%)</td>
<td>13,390 (6.5%)</td>
</tr>
<tr>
<td>1900</td>
<td>15,120 (7.0%)</td>
<td>16,059 (5.3%)</td>
</tr>
<tr>
<td>1905</td>
<td>14,976 (5.2%)</td>
<td>19,941 (5.1%)</td>
</tr>
<tr>
<td>1910</td>
<td>11,970 (3.0%)</td>
<td>16,544 (3.2%)</td>
</tr>
</tbody>
</table>

Source: Data compiled from Latimer, What's Happened to Our High Schools?, 155.

In the last decade of the nineteenth century, science assumed a minor role in the curricula of private girls' secondary schools. In 1893, Great Britain's Gilchrist Trustees sent five female teachers to America to study and report on secondary schools for girls and training colleges for women. In her report, Sara Burstall, mistress at the North London Collegiate School for Girls, noted the presence of Latin in girls' private schools. "Perhaps there is a tendency to do less science," wrote Burstall, "and more history and literature."37

This trend intensified in the twentieth century. By
1914, more girls than boys enrolled in high-school Latin courses across the country. A survey conducted in New York found that among seventh- and eighth-grade students, a larger percentage of girls than boys expressed a preference for Latin. When students were asked which subjects they would most prefer to include in their academic course, girls comprised 64 percent of those who selected Latin. Similarly, a survey of the interests of high school students in Iowa found that of those who stated a preference for Latin over other school subjects, 71 percent were girls. In attempting to explain this phenomenon, the author hypothesized that whereas there was "something inherently attractive to boy-nature in the engineering pursuits," perhaps girls' preference for English, Latin and German was similarly "due to the fact that the intrinsic quality of the subjects makes more of an appeal to the girl-mind than to the boy-mind." Another explanation given for girls' preference of Latin was that the subject, being almost always taught by women, was therefore "presented in ways better suited to arouse the girls' interest than the boys." By the second decade of the twentieth century, women visibly dominated the teaching of Latin in public secondary schools. For example, in Wisconsin, the reports of high-school inspectors written from 1915 to 1924 reveal that the great majority of Latin teachers in that state were women. During this period, inspectors visited 23 Latin teachers, all of whom were
female.41

In spite of these developments, unlike their British sisters, American girls never wholeheartedly embraced the classics. Although Latin appears to have become thoroughly a girls' subject in America by 1914, during the next several decades, the importance of Latin declined in the public high-school curriculum. In contrast to England, where the universities of Oxford and Cambridge maintained the classics in their entrance requirements until relatively late in the twentieth century, American colleges and universities abandoned the classics requirement well before mid-century. For instance, the land-grant University of California eliminated its classics requirement by 1918.42

As colleges and universities began to minimize or omit classical subjects from their entrance requirements, Latin assumed a smaller role in the studies of both sexes. In 1890, 34 percent of all boys and 36 percent of all girls enrolled in high-school Latin courses. By 1928, only 21 percent of boys and 23 percent of girls took the subject, and by 1948, enrollments had fallen to 14 percent of boys and 17 percent of girls.43

The significance of classical study in the history of women's education lies in the fact that the turn to the classics led girls away from science. The underlying motive of educators and parents for encouraging girls to take up classical study was never solely to prepare them to become Latin teachers, although women were highly successful in

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assuming this role. Instead, the goal was to enable girls
to gain entrance to the full four-year collegiate course in
which they might become liberally educated and, in many
cases, to prepare for teaching other subjects than science.
In short--the path away from science led directly to the
liberal arts.

At the turn of the century, some observers of American
culture reported that in addition to adolescent girls, older
women of leisure were also taking up the study of the
liberal arts. "Step by step," announced American
commentator Earl Barnes in an article published in *Atlantic
Monthly* in 1912, "women are taking over the field of liberal
culture:"

> Who, fifty years ago, could have imagined that
today women would be steadily monopolizing
learning, teaching, literature, the fine arts,
 music, the church, and the theatre? And yet this
is the condition at which we have arrived.44

In attempting to explain this phenomenon, another writer,
Josephine Conger-Kaneko, noted that "girls whose mothers had
never advanced much beyond reading, writing, and arithmetic,
find themselves studying Greek art and German music."
Conger-Kaneko speculated that the new studies of their
daughters created in many older women a desire to learn new
things, to "broaden out."45 Across the country, women of
leisure established art and literary clubs, civic
courses, organized university lectures, and enrolled in
correspondence courses, even in the smallest towns.

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Conger-Kaneko described "one town of some five thousand inhabitants out in Kansas [which boasted] half a dozen such clubs."\textsuperscript{46}

By 1910, the vast majority of college-bound girls had abandoned the sciences, choosing instead to study the liberal arts. After 1910, when institutional barriers formed against the relatively few remaining women who sought to become science educators, the liberal arts provided college-bound girls with a well-established educational alternative. This alternative, made possible by the efforts of earlier generations of women, led to careers as educators in such subjects as English, modern languages, Latin, history, or art. In this direction, once the preserve of young men, young women encountered far less competition from males, who now looked with hope of greater personal and financial reward to careers in business, law, medicine, and science.

The Second Path: Home Economics and Commercial Courses

By the late-nineteenth century, girls were turning from science, not only to the classics and liberal arts, but to the new home economics and commercial courses offered in American public and private high schools. While a detailed history of the vocational movement is beyond the scope of this study, an understanding of the underlying issues giving rise to so-called vocational subjects in secondary schools is essential to understanding the eventual impact of this
movement on girls' secondary-school mathematics and science studies.

Even before educators began to consider offering vocational training in American secondary schools, a number of school districts had begun to modify their high-school courses of study to allow students greater election of subjects. Prior to the 1870s, two distinct courses appeared in private and public secondary schools: the Classical Course and the English Course. Following the example set by universities and colleges, however, high schools began to modify these two courses and create new ones to offer a greater range of choices, such as the Latin-Scientific and the English-Scientific courses. For example, in 1874, the high school in Ann Arbor, Michigan offered the following courses: 1) Classical, 2) Latin, 3) Scientific, 4) English, 5) French and Science, 6) German and Science, 7) Latin and German, 8) German, and 9) Commercial.47

Although the proliferation of high-school courses appeared to offer a greater number of educational options, in reality, student choice was still very constrained. For example, in 1874, out of a list of 28 Michigan high schools, none allowed a student to venture from the boundaries of his or her elected course of study. The evils of this system became increasingly obvious to educators. Once he or she had selected an academic course, a student's fate was sealed. The only option for an individual who regretted an ill-advised decision was to start over from the beginning in
In large measure, such restructuring was due to the

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recognition that relatively few secondary school students went on to college. As a greater variety and number of students enrolled in secondary schools in the nineteenth century, some observers began to question the desirability of schooling working-class boys and girls in the traditional curriculum that had long been the domain of elites. In 1874, Horace Greeley, editor of the New York Tribune, expressed a view that a growing number of educators appeared to share:

I go into one of our public schools, and before me are boys who are to work in shops or mills or till the soil all their lives, and there are girls who are to be wives and mothers of farmers and mechanics; to cook, sew, darn, wash, starch, and make butter and cheese; and when I see them studying Algebra and Trigonometry and Logarithms, and making astronomical calculations, I ask, not whether such studies are not useful for some purposes and persons, but whether this does not preclude or take the place of what would be more useful, what they will urgently need to know.52

In 1876, the National Education Association created an Industrial Section, a response to a growing national interest in adapting schools to students' presumed vocational futures.53 Many late nineteenth-century Americans recommended vocational education as a way to make American schools more appealing to working-class boys. For instance, Omaha's superintendent, after noting the high attrition rate of boys from the higher grades of high school, hoped that with the addition of vocational courses to the city's schools, "we shall find before long in the graduating classes nearly as many young men as young
women. In 1904, the state superintendent of Wisconsin justified the addition of vocational training in high schools as a means of increasing the self respect of boys "who naturally have very little taste for intellectual pursuits" and who "are frequently made to feel, in our literary courses of study, that they are of inferior ability."

The debate over how schooling should best fit boys raised the corollary question: what sort of schooling is best for girls? Contemporaries called this "the woman question." It could not be answered without first addressing the larger issue of women's social, political, and economic role in society.

Conservatives argued that because women's place was in the home, the most practical life-training available to girls was home economics, initially known as domestic science. The General Federation of Women's Clubs took the position that young women's studies should be consistent with their future roles as wives and homemakers. Rather than study Greek art and Latin verbs, members argued that girls should learn about cooking, mending, hygiene, and health. Some leading women's magazines promoted and popularized this view as well. The educator Earl Barnes noted in 1912 that "one of these journals, which boasts a fabulous circulation...oppose[s] the larger interests of women in education, industry, and political life." Although a conservative himself, Barnes found it ludicrous that
American women would pay "one dollar and a half a year" to read monthly articles telling them "to go back to their kitchens, churches, and children."\textsuperscript{56}

Liberals, interested in correcting gender inequalities in the workplace, argued that girls should have equal access to the trade and vocational education afforded boys. The National Women's Trade Union League expressed the view that "young women should have access to the same training and educational opportunities as young men." The League strongly objected to the growing practice in some high schools of offering domestic science to girls while limiting trade training to boys. In a speech at the League's 1913 biennial meeting, Margaret Dreier Robins described a case at one school in which boys learned elementary physics, mechanics, and electricity in the science course of an industrial education program, whereas in a differentiated science course for females, girls studied the removal of stains from clothing and the action of alkalies.\textsuperscript{57}

In spite of such protests, several large school districts began to experiment with ways to differentiate the science offered the two sexes. In a highly publicized experiment in limited segregation in Englewood High School in Chicago in 1906, principal J.E. Armstrong tracked boys into science courses that emphasized experimentation and logical reasoning, and girls into courses that focused on the application of scientific principles to the activities of the household. Armstrong reported the experiment to be a
success; grouped together and sheltered from academic competition with girls, boys' enrollment increased from 34 to 38 percent.\(^{58}\) Reporting on a similar experiment several years later, Earl Barnes remarked approvingly that in the Girls' Evening High School in Philadelphia, "the only science courses given...are those in domestic science."\(^{59}\)

Over the following decade, other school districts experimented with sex-segregated science courses in an effort to appeal to the interests of boys and to adapt science content to the presumed life goals of the two sexes. For example, in 1915, A physics teacher in Seattle authored an article advocating the new method of segregating and differentiating science courses, noting that it was now possible to omit "much of the most difficult part for the girls" and present more challenging material to the boys.\(^{60}\) In the same year, the high school in San Jose, California offered a physics course for girls, in which students learned about vacuum cleaners, sewing machines, "the illuminating power of wall surfaces, the efficiency of lamps, and a comparison of colors."\(^{61}\) In 1919, chemistry teacher Will Courson described a course he had designed specifically for girls, claiming that "eminent educators have practically agreed that the highest training that can be given girls is that which pertains to home life." Reflecting these views, Courson's chemistry course included such topics as "How to make good bread."\(^{62}\)

Despite the glowing reports as to the ostensible
success of such experiments, the practice of providing segregated instruction in science classes did not become widespread, largely for reasons of financial and institutional constraint. Offering separate courses to boys and girls was costly, requiring additional faculty and a large student body from which to create multiple courses. Few high schools had sufficiently large enrollments to allow the kind of sexual segregation undertaken in Chicago and Seattle. In 1904, more than 66 percent of students attended relatively small high schools having a faculty of only one to ten teachers.63

Instead, high schools began to differentiate their curricula by introducing sex-typed vocational courses, usually offered as electives. For example, in 1904 Wisconsin required its public high schools "to gradually introduce [for the benefit of boys] work in wood, mechanical drawing, forge work, and work with the lathe in metals, together with work for girls in sewing and cooking."64 By 1920, most public and private secondary schools in the nation offered their students some form of vocational training along these lines, together with commercial or business courses.

Why did parents support the introduction of home economics into the high-school curriculum? Earlier in the century, middle- and upper-class parents had not viewed domestic science as a particularly useful subject for their daughters.65 Nellie Kedzie Jones, pioneer founder of the
first home economics department at Kansas State Agricultural College, recalled that when the subject first appeared in colleges and universities during the 1880s, many male college authorities opposed it on the grounds that "My wife knows how to keep house," and "there is no need to teach girls to cook." Similarly, in 1882 the city superintendent of Omaha questioned the value of introducing a domestic economy course in the city's high schools, noting that girls already "learn every kind of home industry" within the family circle.

By the twentieth century, the perceptions of many Americans as to the value of domestic science was changing, for a number of reasons. First, the growing field of home economics at the college and university level offered middle-class women increased employment opportunities as members of university faculties. According to Jones, after the home economics department at Kansas State Agricultural College staged a successful, highly publicized exhibition at the Chicago World's Fair, "it was not long before young women were called on to go to other Land Grant colleges to organize departments for teaching homemaking." Often the first full professorships awarded to women went to faculty members in departments of domestic science. For example, Cornell University elected Martha Van Rensselaer of the College of Home Economics its first female professor in 1911. Nellie Jones was the first woman to be granted an emeritus professorship at the University of Wisconsin at
Second, home economics appealed to members of the middle and upper classes who promoted the subject as a means of solving a growing servant problem. According to historian Jane Barnard Powers, between 1910 and 1920 the number of domestic servants nationwide fell by approximately 25 percent. Federation Club women noted with anxiety the increasing scarcity of servants and the low skills of the few workers available. "It is perplexing," commented one club woman, "because working women are generally unwilling to accept domestic service as a means of gaining a living, and...the woman heads of families are doing little to improve the situation."71

In contrast to earlier generations of educators who had sought, without much success, to introduce domestic science to middle-and upper-class girls in private secondary schools, middle-class women now targeted lower- and working-class girls, often of immigrant parentage, as the audience most needful of domestic training. "I hail with delight," wrote Wisconsin's state superintendent in 1904, and trust it is not a mere passing fad, that many of the wealthiest women and leaders in society are, within the last few years, beginning to give time, money, and the weight of their influence in the direction of training girls in the supervision and care of the home.72

Another factor in the increased support for home economics was the desire of many parents and educators to
offer girls courses comparable to the new vocational programs available to boys. At the college level, Nellie Jones reported that in spite of initial resistance, "as women began to see how their daughters enjoyed the work, pressure was brought to bear, and many a college...[added] Home Economics...just to please the women." As the home-economics movement gained ground, well-meaning male educators also began to pressure local school authorities to add home economics courses. For example, during a visit to the high school in Bloomer, Wisconsin, inspector R.A. Walker noticed in 1928 that the school "offers no instruction in home economics," although it provided "instruction in agriculture for the boys." Walker wrote to the principal to suggest that, in all fairness, "girls are entitled to as much consideration with respect to home economics...you have plenty of room in the building which might be fitted up for domestic science." Matching boys' vocational courses with similar offerings for girls also solved administrative scheduling problems. Historian Geraldine Jongich Clifford notes that the introduction of home economics and other sex-segregated courses for girls effectively balanced boys' and girls' courses so as to preserve the basic coeducational mix in the remaining areas of the curriculum.

Finally, home economics courses, like other sex-typed courses, undoubtedly appealed to female students who enjoyed participating with other girls in activities related to girl-culture. According to Jones, shortly after she joined
Kansas State Agricultural School to establish its new department of home economics, "a group of girls graduating next commencement came and asked for a sewing class." In response, Jones suggested that each sew her own graduation dress, with the result that at commencement, "the newspapers made great stories of the beautiful dresses, and thereafter sewing was a permanent course for every girl in college."  

Although sometimes billed as a form of science, and described under such various names as "home science," "domestic economy," "household science," "science and art," or "home management," Jones gave the opinion that "what ever name was used, the teaching was homemaking."  

George Counts of Teachers College, Columbia, corroborated this view in a secondary-school survey conducted in the mid-twenties, concluding that the field consisted primarily of cooking and sewing classes rather than science.  

In spite of fairly widespread support among educators and community members, home economics was never as popular among high-school girls as were the newer commercial courses (see Table 5.) College-bound girls preferred instead to concentrate on courses that were required for entrance to colleges and universities. Those seeking employment directly after high school sought to learn clerical skills in the hopes of landing office jobs that paid higher wages than could be earned by those in domestic service.
Commercial education afforded girls a greater degree of respectability and status than did home economics. Clerical work was a white collar occupation that offered some degree of economic and social mobility. As Jane Bernard Powers notes, some women climbed a ladder of advancement that led, within the restricted sphere of female office work, to the desirable position of private secretary. It was also a respectable way for young women to earn a living before marriage, and even to meet promising young men "on the job," becoming for the first time a significant alternative to teaching. In a study published in 1922, George Counts reported that in Bridgeport, Connecticut, 88 percent of working-class high school girls enrolled in commercial courses. And in New York, whereas first-generation Italian-American families had encouraged their daughters to leave school early to go to work, by the second generation girls stayed longer in school, in part to obtain the training necessary for white-collar jobs in the city's growing clerical labor force.
The first three decades of the twentieth century witnessed a four-fold increase in the percentage of girls enrolled in commercial courses in the last four years of public high school. The growth in commercial course enrollments can be explained by the enormous growth in office and sales work during this period. Historian Maurine Weiner Greenwald demonstrates that during the decade from 1900 to 1910, growth in industrial production created an expanding market for support services, telephone communications systems, insurance firms, advertising companies, and mail-order houses. At the same time, the spread of high-school commercial training created a growing supply of young women available and qualified for office employment. Greenwald shows that "the shift toward specialization was accompanied by a feminization of the clerical field," as the number of women employed in clerical work more or less doubled each decade from 1870 to 1910 (see Table 6).

### Table 6

The Ascendancy of Women Office Workers, 1870-1910

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Number of Office Workers</th>
<th>Number of Women Office Workers</th>
<th>Women as Percentage of All Office Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>68,819</td>
<td>1,823</td>
<td>2.6</td>
</tr>
<tr>
<td>1880</td>
<td>139,819</td>
<td>6,610</td>
<td>4.7</td>
</tr>
<tr>
<td>1890</td>
<td>380,141</td>
<td>73,603</td>
<td>19.4</td>
</tr>
<tr>
<td>1900</td>
<td>614,509</td>
<td>179,345</td>
<td>29.2</td>
</tr>
<tr>
<td>1910</td>
<td>1,525,757</td>
<td>575,792</td>
<td>37.7</td>
</tr>
</tbody>
</table>

The events of the First World War created an increased number of openings in clerical work, which women quickly filled. For example, tens of thousands of women gained entry to clerical positions in the railroad industry during the national emergency produced by the War. After the war ended, some employers continued to hire women in preference to men for such work, because, in the words of a Women's Service Section inspector, "They are not so damned anxious to get out and rustle around. Women are more content with the detailed monotonous work because they are filling in between school and marriage."84

Scholars have noted that in spite of the rhetoric of their supporters, home economics and commercial courses never succeeded in truly vocationalizing American high schools.85 The majority of girls continued to enroll in the basic academic courses, in part because such courses already equipped females to be teachers, office workers, or sales clerks. In the basic courses, girls learned to speak, write, calculate simple sums, take directions, and dress properly. In the twentieth century, it was increasingly the high-school diploma itself, rather than a list of completed commercial courses, that helped a young woman land her first job. For example, the telephone companies preferred girls with high-school experience; a survey conducted in 1912 found that 87 percent of Boston's telephone operators had been to high school.86
Nevertheless, not every student was able to avoid home economics, in spite of its elective status at most secondary schools. Although evidence is sketchy because of the lack of data on special home economics programs, it appears that African American girls were more frequently required to take the subject than were white students. Historian Jane Powers reports that the subject was required for female African American high-school students in Winston-Salem, North Carolina.87 Such differential treatment, coupled with discrimination in the workplace, perhaps explains why African American women were rarely found in clerical work, even in large northern cities; in 1920, only 1 percent of their nonagricultural employment was in clerical and sales jobs. In that year, three-fourths of employed African American females worked as farm laborers, servants, and laundresses.88

Whether by choice or by school mandate, girls' enrollments in home economics and commercial courses came at a cost to other subjects. As shown below in Table 7, the years from 1910 to 1922 witnessed a precipitous drop in girls' mathematics enrollments, accompanied by a commensurate rise in commercial enrollments. Similarly, the percentage of girls enrolled in chemistry and physics declined by two-thirds.
Table 7
Percentage of Females Enrolled in Selected Subjects in the Last Four Years of Public High Schools, 1900-1948

<table>
<thead>
<tr>
<th></th>
<th>1890</th>
<th>1900</th>
<th>1910</th>
<th>1922</th>
<th>1928</th>
<th>1948</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry &amp; Physics</td>
<td>33.6</td>
<td>26.1</td>
<td>18.5</td>
<td>12.8</td>
<td>10.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Algebra &amp; Geometry</td>
<td>67.3</td>
<td>83.5</td>
<td>84.2</td>
<td>56.7</td>
<td>49.4</td>
<td>42.6</td>
</tr>
<tr>
<td>Commercial</td>
<td>11.8</td>
<td>11.1</td>
<td>44.4</td>
<td>47.0</td>
<td>48.5</td>
<td></td>
</tr>
<tr>
<td>Home Economics</td>
<td>26.4</td>
<td>29.8</td>
<td>30.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Data compiled from Latimer, What's Happened to Our High Schools?, 149-50.

In order to enroll in commercial and home economics courses, students had to give up a number of other subjects not required for graduation or for entrance to college. In 1894, the Committee of Ten recommended that two units of mathematics and one of science be required for entrance to college. By 1910, most high schools offered biology in the tenth grade, chemistry in the eleventh grade, and physics in the twelfth. Students desiring to prepare for entrance to college could fulfill the usual requirements by taking biology. Because of the nature of graduation and college entrance requirements, and because of their placement in the higher grades, chemistry and physics assumed the status of elective subjects, a phenomenon resulting in declining enrollments, not just among girls, but among boys as well. "At the present rate of decline," warned an anxious science educator in 1909, "physics will disappear from the high school curriculum about the year 1948."
The intellectual challenges of physics and chemistry were simply not worth the effort for young women who did not require the subjects for high-school graduation or for entrance to college. As high-school student Florence Peck explained in her diary in 1901:

Tried chemistry. And flunked. It is the horridist of hateful things to flunk. I will, I shall "drop" it...I wont need it for the university of R[ochester] and that is where I shall go on account of the "lonesome dollars" in the E.C. Peck family.92

Bucking the trend, biology enrollments actually rose during this period, as shown below in Table 8. In part, this can be explained by the subject's grade placement; students of both sexes may have preferred to fulfill their single science requirement in the ninth or tenth grade before turning to other subjects in grades eleven and twelve. Another reason may be that the social and cultural construction of the life sciences as particularly suitable for women, an ideology developed earlier in the

| Table 8 |
|-------------------------------|------------------|------------------|------------------|------------------|------------------|
| Percentage of Males and Females Enrolled in Biology in the Last Four Years of Public High Schools, 1900-1948 |
| 1890 | 1900 | 1910 | 1922 | 1928 | 1948 |
| Biology |
| Males | 1.0 | 8.9 | 13.2 | 19.5 |
| Females | 1.2 | 8.7 | 14.0 | 19.5 |
| Source: Latimer, What's Happened to Our High Schools?, 149. |
nineteenth century, may have continued to make this subject attractive to girls. Yet another factor was the concomitant drop in girls' mathematics enrollments. The lack of a secure foundation of mathematics left many girls ill-prepared to undertake the study of chemistry and physics.

As part of the wider effort to adjust schooling to students' presumed life goals, a number of school districts began to reduce or eliminate the high-school mathematics course requirement for girls. By the turn of the century, educators from both ends of the ideological spectrum increasingly questioned the value of requiring girls to study advanced mathematics. For example, in 1900, the Report of the Commissioner of Education quoted writer Rebecca Harding Davis, who asserted that girls would be far better prepared "for a full, happy life by a course in dressmaking or cookery and arithmetic," than through the study of "trigonometry and art."93 In a similar vein, Joseph Van Denburg noted the apparent irrelevance of algebra to everyday life when he studied New York City high-school students around 1910. Denburg concluded that high-school seemed "hard, uninviting, and entirely out of keeping with what appear to be the realities of life. The contrast between the abstractions of algebra and the life of the neighborhood is too great to be bridged, save by an arch of faith which few indeed can construct."94

In 1904, Wisconsin's state superintendent noted that many public high schools had adopted a proposal to make
Latin and advanced algebra elective subjects. In 1910, the independent high schools of Wisconsin arranged, with the approval of the state university, courses "which do not require algebra in the first year, and which do make physics an elective study for girls." By 1917, some of the public high schools in the state had followed suit, cutting algebra as a required subject to half a year, or even making it "an elective altogether for students in vocational courses, such as agriculture and domestic science." According to Ernst R. Breslich of the University of Chicago, as increasing numbers of American high schools lowered or eliminated their mathematics requirements for high-school graduation, "many pupils did not take any mathematics."

The movement to reduce or eliminate the mathematics requirements in high schools stemmed both from efforts to make schooling more "socially useful" and from new developments in the field of psychology. Throughout most of the nineteenth century, educators believed that any form of mental discipline improved the minds of school students in a general way. Since the eighteenth century, this rationale had served as a popular defense for the study of the classics and advanced mathematics. As discussed in Chapter One, it also served to justify the introduction of the sciences in girls' courses of study before mid-century. At the dawn of the twentieth century, however, the theory of mental discipline came under attack from such scholars as Edward L. Thorndike and Charles Judd, who reported numerous
unsuccessful attempts to demonstrate any transfer of learning from one setting to another.99

The effort to provide girls with a more "practical" education, one more suited to their supposed future goals, received added impetus from the creation of a new professional field: vocational guidance. The first National Conference on Vocational Guidance took place in Boston in 1910. Three years later, leaders of this new movement founded the National Vocational Guidance Association.100 In 1910, a National Education Association Committee, asked to make recommendations concerning the vocational education of girls, expressed a common view among professional guidance counselors:

The girls in our schools will be the wives and mothers of the next generation and the courses of study should be so laid out that these girls will lead happier and richer lives and will be more successful as the future homemakers of our cities.101

Guidance professionals aimed to match the talents of the individual to the job. They believed that, based on a scientific study of education and the workplace, appropriate vocational training and guidance could assist pupils to fill their proper roles in society. In 1913, Thorndike wrote optimistically that, once trained in the principles of vocational guidance, "the average graduate of Teachers College in 1950 ought to be able to give better advice to a high school boy about the choice of an occupation than Solomon, Socrates, and Benjamin Franklin all together could
What sort of counsel did guidance professionals offer girls? In the literature published for an audience of parents and educators, guidance professionals described a far more limited range of career choices for females than for males. Most expressed the belief that girls were destined to become homemakers. "In answer to the question, 'What ought women to be?,'" wrote Marguerite Stockman Dickson, a leader in the vocational guidance field, "we say boldly, 'A homemaker.'" According to Dickson, one obstacle to women's successful pursuit of her "ultimate vocation" as homemaker was "the instruction of the times [which] has imbued her with too little respect for her calling." For those girls who sought to enter the workforce, Dickson and other authors followed the recommendations of the National Education Association's Committee on the Vocational Education of Females, which had suggested that girls "train for work in distinctly feminine occupations." Thus, guidance books recommended for girls a narrow range of such sex-typed occupations as factory work, dressmaking, food production, salesmanship, teaching, nursing, and social work.

Such recommendations represented a distinct departure from earlier views. During the 1870s and 1880s, middle-class women had expressed confidence in the opportunities available to them in science. For instance, at a meeting of the New England Women's Association in 1884, a presenter declared that "whether as a woman of wealth or a bread
winner, [women] can find an ample field,

the former in the philanthropic work of the time
and in scientific observation, the latter as
teacher, curator, lecturer in chemical, physical
and biological laboratories, principal and
superintendent of schools or professor of
pedagogy.106

However, by the 1920s, most of the presumed avenues of
opportunity in science appeared to be closing.

In a sharp break with the older nature-study tradition,
science educators of the period applauded the efforts of
local school districts to align science instruction with the
specific interests and activities of males. For example, in
1924, the New York Herald Tribune carried a full-page
article by Gerald S. Craig of Teachers College, Columbia,
describing the science program of a local elementary school.
The entire article concentrated almost exclusively on the
activities of boys. Following the prescriptions of such
leaders as Craig, educators at the school had devised
lessons that highlighted the applications of physics to such
sex-typed male vocations as engineering, believed to be
inherently attractive to boy-nature.107 First-grade boys,
"with the help of the teacher, had wired up doll houses with
electric lights and door bells;" in fourth grade, "some
boys...had been chosen as chief electricians." According to
Craig, "It is not uncommon to have forty boys assemble
voluntarily to report results of [a] study. One has been
collecting fossils, another reports on reptiles..." Craig's
This solitary girl, pursuing a form of nature study in an environment of boy-oriented physics and encouraged to read rather than experiment, must have felt rather out of place, as undoubtedly did a growing number of girls during this time.

Conclusion

In addition to the backlash described in Chapter Seven, the decline of science as a female interest occurred largely as a result of two social developments. The first, originating during the early nineteenth century, was the gradual but eventually successful movement among girls' private secondary schools to introduce the classics in their curricula in order to elevate the status of their institutions. The second, which gained momentum at the century's end, was a national movement to make secondary schools more pragmatic by including commercial and vocational subjects and reducing or eliminating mathematics requirements for graduation.

The effort to reduce or eliminate the mathematics requirements of girls in high schools, judged by contemporaries to have been successfully implemented in many districts, undoubtedly contributed to girls' falling enrollments in certain scientific subjects. For the first
time since the mid-nineteenth century, a growing percentage of twentieth-century girls found themselves without the mathematics foundation necessary to the successful study of chemistry and physics.

By the time the predominantly male science education community erected barriers against women entering their field, as discussed in Chapter Seven, relatively few girls were still interested in pursuing careers as scientists or science educators. Middle- and upper-class college-bound girls had begun to abandon the sciences before the mid-nineteenth century, turning instead to the classics and the liberal arts. Working-class girls and others not bound for college, guided by educators and employers into a narrow range of relatively low-paying sex-typed jobs, turned from science to the new commercial and home-economics courses offered in their high schools.

Understanding the relation of social class and science education in America is central to comprehending not only why females embraced science in the first place after the American Revolution, but why some abandoned it so readily after the mid-nineteenth century. This study demonstrates that elite females relinquished the sciences in favor of other subjects of study likely to afford a greater degree of social status. Few girls of the farming and working classes gained access to the sciences in their schoolrooms until the rise of the public high school movement during the latter half of the century; for newly-freed African Americans, such
opportunity came even more slowly. Even then, their access was not unchallenged for long. Among lower-middle and working-class girls, those who sought to become science teachers faced discrimination, not only at the hands of the newly professionalized science education community, but at the hands of their school administrators, teachers, and guidance counselors as well. For these girls, bombarded with the message that their place was in the home, in domestic service, or in the office, science must have seemed not only out of reach but terribly irrelevant to their future goals.

Notes

(1) Patricia Phillips, The Scientific Lady, 251ff.


(6) Quoted in Woody, A History of Women's Education, I, 341; "Grovesnor & Sheldon's School for Young Ladies," in American Mercury (Connecticut, March 21, 1820); "C & M Beecher's School," in ibid. (Nov. 11, 1823); "Mrs. Kinneer's Seminary at Hartford," in ibid. (May 6, 1828); "Mr. Skinner's Ladies' School," in Daily National Intelligencer (Washington D.C., April 5, 1825); "Mrs. Saunders & Miss Beach's Seminary for

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Young Ladies in Dorchester," in *Columbian Centinel* (Boston, Massachusetts, April 7, 1827); "Mrs. M'Keige's School for Ladies" in *ibid.* (Sept. 19, 1827); "Miss Bordman's School," in *ibid.* (April 20, 1831); "Mrs. Curtis' Boarding School for Young Ladies," in *ibid.*, April 29, 1831; "Mr. and Mrs. Bleecker's School for Young Ladies," in *New York Evening Post* (April 25, 1836); "Miss McCann's Boarding & Day School," in *Baltimore Sun* (Maryland, Aug. 20, 1842).


(9) Schools advertising Latin: "Mr. Persico's Boarding & Day School, Roanoke," in *Richmond Enquirer* (Oct. 9, 1835); "Prince Edward Young Ladies' Seminary," in *ibid.* (Oct. 13, 1835); "Williamsburg Seminary," in *ibid.* (Sept. 8, 1837); "Mr. and Mrs. Miller's School at Dinwiddie," in *ibid.* (Nov. 20, 1838).

(10) James Mulhern examined the catalogs of 36 Pennsylvania girls' schools published from 1750 to 1829. He reported that five (14 percent) of these schools offered instruction in Latin, a proportion similar to that found in Virginia. However, because Mulhern's time period is so broad as to encompass a period of fifty years in which virtually no girls' schools in the nation offered Latin, it is probable that an examination of Pennsylvania catalogs published between the years of 1800 and 1830 would reveal a percentage more comparable to that found in other New England states. See James Mulhern, *A History of Secondary Education in Pennsylvania*, 428.

(11) Schools offering Latin: Raleigh Academy, which offered Latin in its female department in 1811; Hillsborough Academy, which offered Latin in its female department in 1812; Wadesborough Academy, which offered Latin in its female department in 1821, and Mrs. Edmonds' Boarding School, which offered Latin in 1820. Warrenton Female Academy, which taught Latin and Greek in 1822; New Bern Academy which offered both in 1823; Raleigh Female Academy, which offered Latin in 1835. Sparta Academy also offered Latin in 1930, but as it is not possible from the advertisement to determine whether the subject was offered in the female department, I have not included the institution in my sample. My data is drawn from newspaper advertisements included in *North Carolina Schools and Academies*, ed. Coon.

(12) Schools advertising Latin: "Grovesnor & Sheldon's School for Young Ladies," in *American Mercury* (Connecticut, March
21, 1820); "C & M Beecher's School," in ibid. (Nov. 11, 1823); "Mrs. Kinneer's Seminary at Hartford," in ibid. (May 6, 1828); "Mr. Skinner's Ladies' School," in Daily National Intelligencer (Washington D.C., April 5, 1825); "Mrs. Saunders & Miss Beach's Seminary for Young Ladies in Dorchester," in Columbian Centinel (Boston, Massachusetts, April 7, 1827); "Mrs. M'Keige's School for Ladies" in ibid. (Sept. 19, 1827); "Miss Bordman's School," in ibid. (April 20, 1831); "Mrs. Curtis' Boarding School for Young Ladies," in ibid. (April 29, 1831); "Mr. and Mrs. Bleeker's School for Young Ladies," in New York Evening Post (April 25, 1836); "Miss McCann's Boarding & Day School," in Baltimore Sun (Maryland, Aug. 20, 1842).


(15) Quoted in Mulhern, A History of Secondary Education in Pennsylvania, 396.

(16) See Farnham, The Education of the Southern Belle, 12ff. Farnham argues that current scholarly assessments of these schools reflect, not only a northeastern bias, but an unwarranted dependence on the views of earlier scholars, who dismissed women's colleges because they did not offer the classics to the same degree as the leading men's colleges of the period.


(18) Quoted in Farnham, The Education of the Southern Belle, 11.


(20) Ibid.

(21) Ibid., 167; 169-70.

(22) Ibid., 171; 181-2.

(23) Quoted in Farnham, The Education of the Southern Belle, 13.

(24) Ibid., 14-15.

(25) Woody, Women's Education in the United States, 1, 418; James Mulhern, A History of Secondary Education in

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(28) Ibid.


(30) Register of the University of California, 1871 (Oakland, California), 30; Register of the University of California, 1873, 15-6. This pattern, in which more women enrolled in the College of Arts than in the College of Letters, changed drastically after 1874, when the College of Letters divided into two categories: a classical course, and a literary course. Admission to the literary course did not require knowledge of the classics. See Register of the University of California, 1874, 12-4.


(36) Ellwood P. Cubberley, Public Education in the United


(41) Department of the Office of the State Superintendent High School Inspection Reports [Wisconsin], Wisconsin State Historical Society, boxes 1-4. The data are drawn from the reports made by inspectors who visited Wisconsin High Schools. There is no indication that inspectors visited every class at each school, but they gave the subject of those classes they visited, along with teachers' names and brief evaluations of the teaching observed. I collected data at 4-year intervals.


(46) Ibid.

(47) Principal's Report to the Superintendent of Public Instruction, 1874 (Ann Arbor, Michigan, 1875), 255ff.


(54) *Omaha City Schools Annual Report of the Board of Education* (Omaha, Nebraska: Rees Printing Co., 1886), 39; 58.


(64) *Eleventh Biennial Report of the Department of Public Instruction* (Madison: Democrat Printing Co., 1904), 105.

(65) See discussion in Chapter Three.

(66) Nellie Kedzie Jones, typescript of an article "Written for Home Economics Journal," in Nellie Kedzie Jones Papers,
WSHS.

(67) Omaha City Schools Annual Report (1882), 38.

(68) Jones, "Mrs. Nellie Sawyer Kedzie Jones," typescript in Jones papers, WSHS.

(69) Margaret Rossiter, Women Scientists in America: Struggles and Strategies to 1940 (Baltimore: The Johns Hopkins University Press, 1982), 64-5.

(70) "Nellie Kedzie Jones, Teacher is Dead at 97," newsclipping in Jones papers, WSHS.


(72) Eleventh Biennial Report of the Department of Public Instruction, 103.

(73) Jones, typescript entitled "Written for Home Economics Journal," 3, in Jones Papers, WSHS.

(74) R. A. Walker to R.M. DeWitt, March 3, 1928, box 4, Department of Public Instruction High School Inspection Reports, WSHS.

(75) Clifford, "Marry, Stitch, Die, or Do Worse," 242.

(76) Jones, typescript entitled "Mrs. Nellie Sawyer Kedzie Jones," 6, in Jones Papers, WSHS.

(77) Jones, transcript entitled, "What Did You Do?--Questions Asked Me," in Jones papers, WSHS.


(79) Of the apparent decrease in business enrollments in 1910, John Francis Latimer explained that "it could not be determined whether there was an actual decrease in the number of high schools offering business education courses, or simply a decrease in the number reporting them [in that year.]" Quoted in Latimer, What's Happened to Our High Schools?, 37.

(80) Powers, The 'Girl Question' in Education, 41.


(82) See Table 7 below.
Greenwald, Women, War, and Work, 8.


See Clifford, "Marry, Stitch, Die or Do Worse," 251ff.


Clifford, "Marry, Stitch, Die, or Do Worse," 243; 252.

Because of the nature of his sources, Latimer included data for 1900 and 1910 under the heading "Business and Commercial Course." After 1910, Latimer dropped this category and reported separate categories for bookkeeping, shorthand, and typing. In Table 2, I combined these three categories to obtain a total for the years 1922, 1928, 1948, and 1955.

Latimer, What's Happened to Our High Schools?, 68.

C. R. Mann, Physics Teaching as It is and as It Might be in Wisconsin, (Madison: Wisconsin: Democrat Printing Co., 1910), 3.

Quoted in Clifford, "Marry, Stitch, Die, or Do Worse," 259.


Quoted in Clifford, "Marry, Stitch, Die, or Do Worse," 249.


C. P. Cary, State Superintendent, Requirements and Suggestions Relating to High Schools of Wisconsin, (August, 1917), 9, WSHS.

Ernst R. Breslich, "Mathematics," in A Half Century of
Science and Mathematics Teaching (Oak Park, Illinois: Central Association of Science and Mathematics Teachers, Inc., 1950), 58.


(105) For example, see Dickson, Vocational Guidance For Girls; Latham Hatcher and Emery N. Ferriss, Guiding Rural Boys and Girls (New York: McGraw-Hill, 1930).

(106) "History of the Committee on Status of Women," 3, box 5, Elsa Allen Papers, Cornell University Archives.


(108) Gerald Craig, "Kindergarten Children Learn Science Lessons in Modern City School," Herald Tribune, box 1, Gerald S Craig Papers, unprocessed additions, University of Chicago Special Collections. A handwritten note at the top of this news clipping states that it was published in 1924.
Conclusion

By the third decade of the twentieth century, the territory of science belonged to boys. In particular, the cultural construction of the physical sciences as male subjects in secondary schools was complete. This gendered transformation mirrored another 180 degree shift in the curriculum during the previous century: the now commonly held view that Latin and the liberal arts were inherently more appealing to the feminine mind. Having traversed a period of nearly one hundred and fifty years in telling the story of the science education of American girls, it will be useful to review the general findings revealed by this research before turning to its larger significance.

Scientific subjects first entered the school curriculum available to girls through the medium of geography texts. The introduction of geography into post-colonial schoolrooms marked an important shift in the way American began to think about the education of their daughters. Impelled by the social need to train young women as mothers and teachers of subjects perceived to be essential to the progress of the young republic, Americans sanctioned the study of the sciences for their ability to promote mental discipline, foster moral virtue, and convey pragmatic knowledge.

The sciences flourished in the newly-founded girls' secondary schools established during the first half of the
nineteenth century. The reported courses of study of such institutions show a greater departure from the traditional classical curriculum and a more visible emphasis on scientific subjects than the curricula of similar, contemporary institutions for boys.

Initially, girls studied natural philosophy, astronomy, and chemistry primarily in order to attain culture. Throughout a period in which the liberal culture of a classical education was largely forbidden to females, girls took up the sciences in order to become interesting conversationalists, to assist in the promotion of science by making scientific activity fashionable, to improve their mental discipline, and to engage in what was presumed to be a morally uplifting study. Female authors of science texts portrayed girls and women as turning to nature, not to conduct research, but to develop orderly habits of observation, to seek beauty and spiritual solace, to develop a patina of gentility, and to nurture and protect wildlife. Such authors traditionally cast women as popularizers of science rather than as creators of scientific knowledge.

As the prohibition against studying higher mathematics diminished near mid-century, growing numbers of girls' secondary schools introduced algebra, geometry, and trigonometry into their curricula. My findings show that the natural philosophy and astronomy textbooks available to girls included increasing amounts of mathematics after the 1840s; after mid-century, the mathematical complexity of
the most advanced texts used in girls' schools did not differ from those used in boys' schools. And although natural history assumed a larger role in girls' schools from 1840 through 1880, this increase was not accompanied by a corresponding decline in natural philosophy, or physics.

Despite the fact that the mathematical study of natural philosophy was available to girls, evidence suggests that young women preferred the subjects of natural history. Why did girls increasingly turn to natural history after mid-century? I argue that females took up this science because its study afforded them the greatest range of opportunities for meaningful participation, initially as amateurs and ultimately as professionals. It was primarily in natural history that women began to see vocational possibilities in science; in contrast to physics or astronomy, natural history afforded a variety of employment opportunities after mid-century. As part of the effort to ease women's entry into this field, female authors actively promoted natural history as an arena of endeavor particularly compatible with women's sphere. While such authors can be portrayed as limiting the range of women's potential roles in science, they can also be viewed as creating a non-controversial arena in which middle- and upper-class women could begin to participate and even earn a living of sorts.

The sex-typing of natural history -- its cultural
construction as a subject peculiarly suitable for women --
proved to be a two-edged sword. On the one hand, sex-typing
encouraged women's participation in this science and perhaps
assuaged anxiety the male scientific community may have had
about females' increasing pursuit of science as a vocation.
On the other hand, because sex-typing portrayed women as
involved in natural history for reasons of culture,
gentility, or aesthetics, educators interested in promoting
scientific subjects for vocational reasons became
increasingly skeptical of women's participation in science
education near the end of the nineteenth century.

During the late nineteenth and early twentieth
centuries, women seeking employment opportunities in science
faced discrimination, not only at the hands of the
professional science community, but within the educational
community as well. Women's references to natural theology,
culture, and nature appreciation during the nature-study
movement became easy targets for nature study's critics. As
women began to compete directly with men for leadership
positions in science education, the sex-typed feminine
culture they brought to nature study became an easy target
for a political backlash supported by underlying social and
economic concerns.

I argue that the eventual decline of science as a
girls' subject occurred as the result of three social
developments. The first, originating during the early
nineteenth century, was the movement among girls' private secondary schools to introduce the classics in their curricula in order to elevate the status of their institutions. Early nineteenth-century girls first took up the study of the sciences during a period in which the study of the classics was commonly restricted to boys. During this era, the sciences afforded a degree of cultural polish -- a second-rate polish, no doubt, since the classics had long been viewed as the most fitting vehicle for the transmission of liberal culture -- but a polish that was within reach for elite females.

As the prohibition against studying classical subjects diminished during the nineteenth century, girls began to take up the classics in their secondary schools. Female educators introduced Latin as a means of enhancing the status of girls' schools and in order to prepare their students to fulfill the entrance requirements of the collegiate courses in the post-secondary institutions open to women after the Civil War. Additionally, as the contributions of middle- and upper-class amateurs became more marginalized within the emerging communities of professional science in the later nineteenth century, science itself seemed a less suitable vehicle for the promotion of culture -- a role now most admirably filled by classical study. Inevitably, taking up the classics resulted in a diminished study of the sciences in female institutions.
A second development in the decline of the sciences among girls was the societal backlash against female teachers at the end of the nineteenth century. Although a majority of girls may have relinquished the sciences in favor of the classics and liberal arts near the century's end, some girls had continued to study the sciences in preparation for teaching science at the high-school level. Ultimately, however, a negative reaction to the growing influence of female educators in general, and to female science teachers in particular, prompted a policy of discrimination against women in faculty hiring for secondary and post-secondary positions. The inevitable result was a gradual decrease in the proportion of women in the field of science education.

A third factor in the decline of science as a girls' subject was the late-nineteenth-century progressive effort to make schooling more "practical." At the close of the century, educators across the country allowed students an increased election of studies and offered a greater array of vocational subjects in secondary schools. During the same period, many school districts reduced or eliminated their mathematics requirements for girls, impelled by a rising belief that algebra and geometry were not particularly useful studies for a young girl's future role as homemaker. As a result of their declining enrollments in these subjects, for the first time since the mid-nineteenth
century, a growing percentage of twentieth-century girls were without the educational foundation necessary for the study of mathematical physics. The promotion of home economics and commercial courses by high-school vocational guidance counselors undoubtedly provided additional encouragement to girls desirous of enrolling in these newer subjects, viewed by many as eminently more practical than algebra, physics, or chemistry.

On the one hand, the decline of science as a girls' subject can be viewed as the result of discrimination against women by males in the science education community. This depiction casts females as victims and follows a storyline now familiar in feminist accounts of women's experience in the broader history of science. On the other hand, the decline of science as a girls' subject can also be interpreted as an unintended result of a broader strategic effort on the part of women to elevate the status of female education by pursuing the liberal arts and the classics. This latter interpretation casts women as active agents in their own educational destiny.

In her history of women scientists in America, Margaret Rossiter notes that the numbers of women in scientific fields at the dawn of the twentieth century were nearly invisible due to "the camouflage intentionally placed over their presence in science in the late nineteenth century." While such camouflage may have been intentional on the part of some males in the scientific community, for
females, it was also an unintended consequence of strategies initially undertaken to advance female education and to enhance the status of women's work. Earlier in the nineteenth century, when secondary-school science was a girls' subject because of its relative unimportance in American education, most women turned their attention from science to the liberal arts. By the dawn of the twentieth century, when a minority of persevering and dedicated women began to enter the scientific professions, their efforts were all but invisible, not only because their male colleagues may have preferred to ignore them, but because the vast majority of American women were simply no longer interested in science.

The significance of this study lies, not only in the questions it raises for further historical research, but also in its implications for current policy and practice. Educators interested today in advancing the sciences and mathematics among girls attempt an array of interventions. Among these are curricula and instructional methods believed to address inherent differences between males and females. For instance, some curriculum developers have advocated a mathematics curriculum that emphasizes exercises in logic and spatial reasoning, mental skills in which females have been presumed deficient. Other educators, believing that females tend more naturally toward collaborative and cooperative activity, stress the importance of developing
science and mathematics courses that emphasize cooperative learning, team research projects, and so on.

While such efforts may be laudable, this study suggests that the assumptions on which they are founded are misplaced. It is clear that girls' interest and achievement in science and mathematics have been historically mediated by economic, social, and cultural forces rather than determined by inherent biological traits or abilities. After all, during the historical period in which girls appear to have been most interested in science -- the early and mid-nineteenth century -- no one had conceived of the modern notion of cooperative learning; instruction occurred largely through recitation from texts. Similarly, twentieth-century girls' relatively lower achievement in spatial reasoning tasks may be attributed to girls' decreasing enrollments in high-school geometry courses during the earlier twentieth century rather than to any inherent biological deficit in reasoning ability.

What then is the process by which girls begin to view a science as a worthwhile subject of study? The story of women's growing involvement in natural history affords an interesting case from which to draw several conclusions. Three factors stand out from the historical record as having been enormously successful in encouraging girls to take up this science. The first was the opportunity for meaningful participation. First as amateurs, women's involvement in
such fields as botany was welcomed by males because the task of cataloging the flora of North America was so enormous. Later in the century, natural history provided women with opportunities for gainful employment, in nurseries, museums, agricultural experiment stations, flower shops, horticultural gardens, the United States Department of Agriculture, and so on.

A second factor that eased women's entry into the fields of natural history was the support and patronage of some prominent and highly influential males in the field. Such scientists as Asa Gray, Louis Agassiz, and Liberty Hyde Bailey supported women's participation as collectors, museum and laboratory assistants, and as teachers. In contrast, there were no comparable male physicists encouraging women to participate in that science during the nineteenth century. And while Edward Pickering, as director of Harvard College Observatory, began to hire female assistants in astronomy near the end of the nineteenth century, opportunities in astronomy were minimal compared to those in natural history.²

A third important factor in the rise of natural history among nineteenth-century girls was the process of sex-typing by prominent females. The rhetoric advanced by female educators portrayed this science as eminently suited to women's sphere. During a period when natural history afforded women the widest possible arena for participation
in science, female educators characterized the biological sciences as particularly appropriate for women. Similarly, when a shortage of mathematics teachers occurred at the secondary level near mid-century, women took up positions as algebra and geometry teachers, protected from potential social opprobrium against entering a previously male sphere by the feminization of school teaching itself.

Today, biology continues to be a science in which women have been relatively successful in terms of their numbers and achievement. We take this state of affairs so much for granted that we overlook the fact that the course of events could have taken a different path. After all, at the dawn of the nineteenth century, social mores dictated that a woman could neither collect specimens in the field nor dissect. Changes in attitudes towards women's participation in the life sciences arose as the result of the rhetorical efforts of both female and male scientists and educators to open the doors of natural history to women. Women moved out into the field under the cover of a rhetoric that portrayed them both as nurturing conservationists and as frail creatures needful of outdoor exercise. Later in the century, females took up dissection protected by the argument that America required their labor in the field of secondary-school science education.

Throughout most of the period covered by this dissertation, the study of the sciences was reserved to the
daughters of middle- and upper-class Americans. Understanding the relation of social class and science education in the United States is central to comprehending not only why females embraced the sciences in the first place after the Revolution, but why some abandoned it so readily during the later nineteenth century. This study demonstrates that elite females began to relinquish the sciences at mid-century in favor of other subjects of study more likely to afford a greater degree of social status and entrance to the more prestigious collegiate courses in post-secondary institutions.

Relatively few girls of the farming and working classes gained access to the sciences in their schoolrooms until the rise of the public high school movement during the last decades of the century. For newly-freed African Americans, such opportunity came even more slowly. After the 1870s, however, girls from a broader range of socioeconomic and ethnic backgrounds studied science in order to become schoolteachers. It was this group that bore the brunt of the social backlash against women science educators that arose at the dawn of the twentieth century. Those who sought to become science teachers faced discrimination, not only at the hands of the newly professionalized science education community, but at the hands of their school administrators, teachers, and guidance counselors as well.

This study suggests several areas for further research. In order to know why African Americans, Native Americans,
Hispanics, and other ethnic groups have been historically under-represented in the sciences, it is important to learn more about the nature of the science education available to them. At different period of history, how has science been viewed by individuals from these and other ethnic groups? And how has their participation in science been limited or enhanced by institutional and organizational structures established by the dominant elite?

To fully understand the issues involved in women's increasing participation in nineteenth-century mathematics and science education, we also need to hear the individual voices of those early young women who became secondary-school science and mathematics teachers. What were their experiences in undertaking a role that had previously been assigned primarily to males? What influenced them to take up this particular career path? To what extent were women science educators aware of the social backlash and job discrimination that eventually thinned their ranks in the twentieth century?

Throughout the past year, as I have presented papers based on my research at various conferences, audiences have asked the question, "Why have we not known this story until now?" In part, I believe it is because few individuals interested in science and mathematics undertake historical research, and few historians of education interest themselves in science and mathematics. And of the
relatively small number of scholars who do labor in the intersection of the history of education and the history of science, fewer still have considered the historical experience of adolescents. There is much more to learn. To a very great extent, the story of the science education of American girls has only begun to be told.

Notes

(1) Margaret Rossiter, Women Scientists in America: Struggles and Strategies to 1940 (Baltimore: Johns Hopkins University Press, 1982), xi.

(2) For a discussion of the women at Harvard College Observatory, see ibid., 53-57.
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**Newspapers**

The following newspaper series were obtained from microfiche and the Post-Colonial Newspaper Collection at Special Collections, Stanford University.


**Baltimore Sun** (Baltimore, Maryland) Aug. 12, 1842-Aug. 23, 1842.

**The Columbian Centinel** (Boston, Massachusetts) 1827; Jan., 1831-Mar. 1833.

**Daily National Intelligencer** (Washington D.C.) 1825.


**Maryland Gazette** (Annapolis, Maryland) Jan. 5, 1832-Oct. 22, 1835.


The **Philadelphia Gazette** (Philadelphia, Pennsylvania) 1824.

The **Richmond Enquirer** (Richmond, Virginia) Sept. 29, 1835-Nov. 17, 1837.

**Periodicals**

Runs of the following magazines and journals constituted an important source for this study:

- **American Annals of Education**, 1831-1834
- **The American Journal of Education**, 1870-1890
- **The American Naturalist**, 1871-1872
- **The Nature Study Review**, 1905-1920
- **Popular Science Monthly**, 1872-1882
- **School Science and Mathematics** 1905-1932
- **St. Nicholas Magazine**, 1882-1888
- **The Youth's Companion**, 1850-1905

**Documents in Special Collections**


Omaha City Schools Annual Report of the Board of Education. Omaha, Nebraska: Rees Printing Co., 1886.

The Blue and Gold, IV. Berkeley, California: The University of California, 1877.


---------------------Tenth Annual Register, 1900-1901. Palo Alto, California: University Press, 1901.


Schools Inquiry Commission. General Reports of the Assistant Commissioners, Southern Counties, VII. 1867-68.


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The University of California Register, 1870. Oakland, California, 1871.

The University of California Register, 1871. Oakland, California, 1872.

The University of California Register, 1873. Oakland, California, 1874.

The University of California Register, 1874. Oakland, California, 1875.

The University of California Register, 1907-8. Berkeley, California, 1908.

The University of California Register, 1911-12. Berkeley, California, 1912.


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Government Documents


Printed Contemporary Sources


Cooper, Susan Fenimore. Rural Hours New York: George P. Putnam, 1850.

Corbin, Caroline Fairfield. Socialism and Christianity With Reference to the Woman Question. Chicago, 1905.


**Secondary Sources**


Co., 1925.


Powers, Jane Bernard. *The 'Girl Question' in Education: Vocational Education for Young Women in the Progressive*


Wray, Ruth Arline. The History of Secondary Education in Cumberland and Sagadahoc Counties in Maine. (Orono, Maine, 1940).


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### Table 1

Astronomy, Chemistry, and Natural Philosophy Textbooks
Mentioned in Female Seminary Catalogs and Newspaper Advertisements, 1780-1850

<table>
<thead>
<tr>
<th>Astronomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rev. J. L Blake, First Book in Astronomy (1831)</td>
</tr>
<tr>
<td>Hannah M. Bouvier, Bouvier's Familiar Astronomy (1855)</td>
</tr>
<tr>
<td>Elijah H. Burritt, The Geography of the Heavens (1849)</td>
</tr>
<tr>
<td>Alva Clark, A New System of Astronomy (1820)</td>
</tr>
<tr>
<td>John Lee Comstock, Youth's Book of Astronomy (1835)</td>
</tr>
<tr>
<td>James Ferguson, An Easy Introduction to Astronomy for Young Gentlemen and Ladies (1805)</td>
</tr>
<tr>
<td>__________________________ Lectures on Select Subjects in Mechanics.</td>
</tr>
<tr>
<td>Hydrostatics, Pneumatics, Optics, and Astronomy</td>
</tr>
<tr>
<td>Samuel S. Goodrich, Peter Parley's Sun, Moon, and Stars</td>
</tr>
<tr>
<td>Joseph Guy, Guy's Elements of Astronomy</td>
</tr>
<tr>
<td>Sir John F. W. Herschel, A Treatise on Astronomy (1836)</td>
</tr>
<tr>
<td>Ezra Otis Kendall, Uranography, or, A Description of the Heavens (1844)</td>
</tr>
<tr>
<td>Hiram Mattison, An Elementary Astronomy for Academies and Schools (1846)</td>
</tr>
<tr>
<td>Hiram Mattison, A High-School Astronomy (1853)</td>
</tr>
<tr>
<td>Denison Olmsted, Letters on Astronomy, Addressed to a Lady (1840)</td>
</tr>
<tr>
<td>__________________________ An Introduction to Astronomy (1839)</td>
</tr>
<tr>
<td>__________________________ Outlines of a Course of Lectures on Astronomy</td>
</tr>
<tr>
<td>__________________________ An Compendium of Astronomy (1839)</td>
</tr>
<tr>
<td>__________________________ An Introduction to Astronomy, ed. E.S. Snell (1860)</td>
</tr>
<tr>
<td>Robinson, Horatio Nelson, An Elementary Class Book on Astronomy (1857)</td>
</tr>
<tr>
<td>Ryan, James, The New American Grammar of the Elements of Astronomy (1839)</td>
</tr>
<tr>
<td>Vose, John, A System of Astronomy (1827)</td>
</tr>
<tr>
<td>Wilkins, John Hubbard, Elements of Astronomy (1823)</td>
</tr>
</tbody>
</table>

1. When known, the initial publication date of each text is included in parentheses after the title. Thomas Woody's list included two textbooks that I have been unable to locate in the archival sources available to me: chemistry texts by Cotting and Quackenbos. There is no mention of these texts in such secondary sources as John A. Nietz's The Evolution of American Secondary School Textbooks (Rutland, Vermont: Charles E. Tuttle Co., 1966).

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Table 1 (continued)

Chemistry

1800-1835
Blake, *Conversations on Chemistry*, (1806)
Eaton, Amos, *Chemical Instructor* (3rd ed., 1828)
Gray, Alonzo, *Elements of Chemistry*, (1840)
Jones, Thomas P., *Conversations on Chemistry* (1831)
Marcet, Jane, *Conversations on Chemistry* (1806)
Parkes, Samuel, *The Rudiments of Chemistry* (1810)
Phelps, Almira Hart Lincoln, *Chemistry for Beginners* (1834)
Renwick, James, *First Principles of Chemistry*, (1840)
Silliman, Benjamin, ed. *The Elements of Experimental Chemistry* (1814)
Stockhardt, Julius Adolph, *The Principles of Chemistry* (1851)
Edward Turner, *Elements of Chemistry* (1827)
Webster, John W., *Manual of Chemistry* (1828)
Wells, David A., *Principles and Applications of Chemistry* (1858)

Natural Philosophy

1800-1835
Arnott, Neil, *Elements of Physics, or Natural Philosophy* (1827)
Blake, *Conversations on Natural Philosophy* (1829)
Bryan, Margaret, *Lectures on Natural Philosophy*
Comstock, John Lee, *A System of Natural Philosophy*, 1831
Ferguson, James, *An Early and Pleasant Introduction to Sir Isaac Newton's Philosophy* (2nd ed., 1772)
Gale, Leonard D., *Elements of Natural Philosophy* (1851)
Gray, Alonzo, *Elements of Natural Philosophy*, (1850)
Grund, Francis J., *Elements of Natural Philosophy* (1835)
Johnston, John, *A Manual of Natural Philosophy*, (1851)
Jones, Thomas P., *Conversations on Natural Philosophy* (1826)
Olmsted, Denison, *An Introduction to Natural Philosophy* (1844)
----------, ed. E. S. Snell, *An Introduction to Natural Philosophy* (1860)
----------Rudiments of Natural Philosophy and Astronomy* (1844)
Parker, Richard Green, *A School Compendium of Natural and Experimental Philosophy* (1850)

1. Thomas Woody simply listed Margaret Bryan's name as an author in his list of textbooks, without giving the title. Since many Americans commonly thought that Jane Marcet's Conversations on Chemistry was written by Bryan, this may indicate the use of Marcet's, rather than Bryan's text.
Table 1 (continued)

Peck, William G. (Ed.) *Ganot's Popular Physics* (1860)

Phelps, Almira Hart Lincoln, *Natural Philosophy for Beginners* (1838)


Swift, Mary, *First Lessons on Natural Philosophy* (1833)

Wells, David A. *Wells's Natural Philosophy*, (1857)
### Table 2

Astronomy, Chemistry, and Natural Philosophy Textbooks
Not Mentioned in Female Seminary Catalogs or Newspaper Advertisements,
1780-1850

<table>
<thead>
<tr>
<th>Astronomy</th>
<th>Chemistry</th>
<th>Natural Philosophy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbott, The Young Astronomer (1846)</td>
<td>Beck, Lewis C., A Manual of Chemistry (1838)</td>
<td>Cavallo, Tiberius, The Elements of Natural or Experimental Philosophy (1803)</td>
</tr>
<tr>
<td>Brocklesby, John, Elements of Astronomy (1855)</td>
<td>Francis, G., Chemical Experiments (1850)</td>
<td>Everett, J.D., Deschanel's Elementary Treatise on Natural Philosophy (1863)</td>
</tr>
<tr>
<td>Dick, Thomas, The Geography of the Heavens (1833)</td>
<td>Gale, Leonard D., Elements of Chemistry (1835)</td>
<td>Fischer, E. S., Elements of Natural Philosophy (1827)</td>
</tr>
<tr>
<td>M'Intire, James, New Treatise on Astronomy (1850)</td>
<td>Norton, William A., An Elementary Treatise on Astronomy (1845)</td>
<td>Loomis, Elias, Elements of Natural Philosophy, 1858</td>
</tr>
</tbody>
</table>

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