RITTENHOUSE

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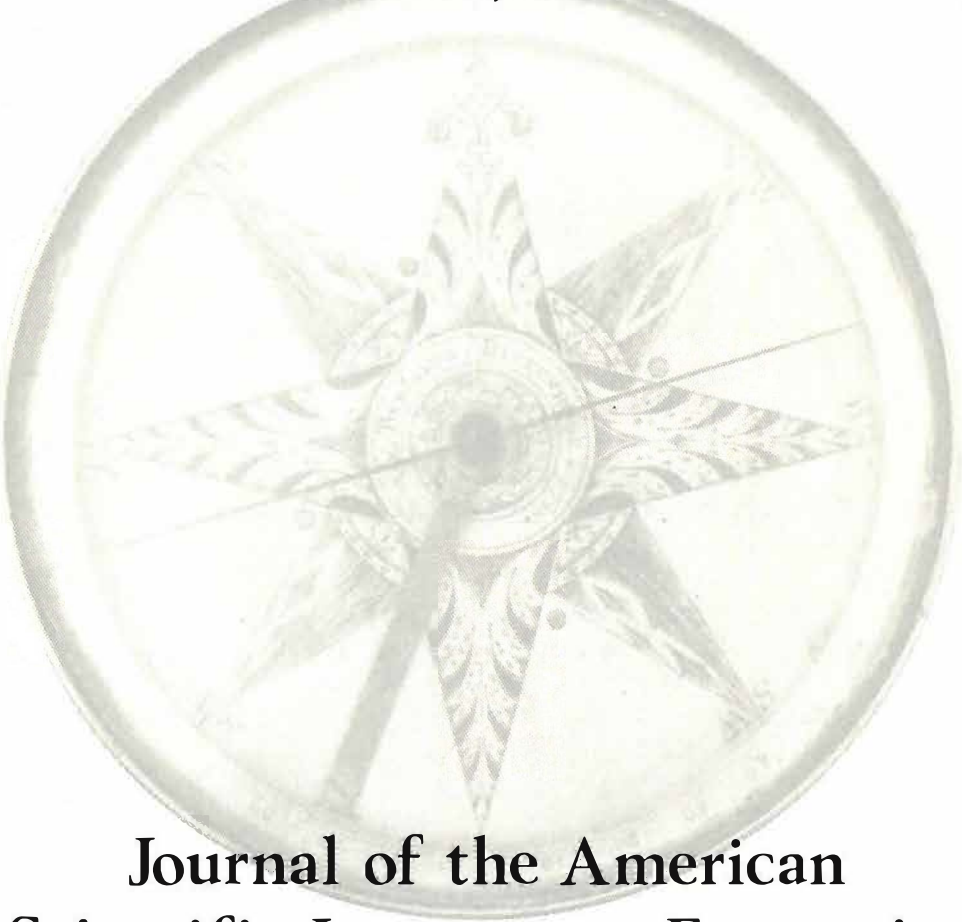

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TOOLS FOR TEACHING AND RESEARCH: JOHN PRINCE, THE DEERFIELD ACADEMY, AND EDUCATIONAL REFORM IN THE EARLY REPUBLIC

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In April and May 1808, the *Greenfield Gazette* ran a weekly advertisement for the Deerfield Academy in Massachusetts. Incorporated in 1797, the Deerfield Academy enrolled both young men and women, and the advertisement was aimed at prospective students and their families.[1] What were the Academy's selling points? A fine library and cabinet of scientific instruments; able instructors; and practical courses of instruction. The instruments had been recently purchased from W. and S. Jones of London with the help of the Reverend Dr. John Prince of Salem. The Academy's trustees were rightly proud of the new apparatus, showing it off to Massachusetts Governor Gore and his wife when they stopped at Deerfield en route from Boston to Saratoga Springs in August 1809.[2]

Surviving information about the instruments is meager but worthy of a close look. In the first part of this essay, I will reconstruct the path the trustees took towards the purchase of the apparatus and probe the depth of their commitment to science instruction and research. In the second part, I will closely analyze the list of instruments purchased, shedding new light on John Prince's business relationship with W. and S. Jones, his role as a vendor of scientific instruments to American academies and colleges, and the synergy between Prince's instrument-making and merchandising activities. I will also point out that Deerfield's apparatus was used both for teaching and research, and was equal in quality to the instruments acquired by contemporary New England colleges. Why a rural academy invested so heavily in natural philosophy is the question that leads off the third and last part of this essay. The answer has as much to do with economics as with social vision. To this end, I will compare the instructional goals of academies and colleges in Deerfield's day, but will argue, contrary to the received view, that academies were not trend-setters when it came to training in science, but followed the lead set by their college rivals.

Plans and Needs

The *Gazette* advertisement readily conveyed the pride Deerfield's trustees felt for their institution, but its insertion in the newspaper was done as a matter of urgency. Since the school had opened its doors on 1 January 1799, the annual enrollment had risen steadily to a height of 238 in 1804.

However, in 1805 the enrollment had fallen to 207, and in 1806 it stood at 154. Thereafter the decline was gradual, bottoming out at 114 in 1809, shortly before the Academy temporarily shut down in order to remodel and enlarge its building.[3]

The troubling and puzzling decline in enrollments encouraged the school's trustees to act. One way to make the school more attractive was to beef up its science curriculum. The founding trustees had always expected Deerfield's preceptor (or principal instructor) to teach natural philosophy, and three major donations in 1798 insured that he had the tools for the task: Mr. David Wells of Greenfield, Deacon Jonathan Arms of Deerfield, and Mrs. Abigail Norton of Deerfield, had each made gifts of land whose proceeds were to be used for the express purpose of purchasing an air pump and other philosophical apparatus. Sale of this land netted the Academy about five hundred dollars by 1804. That same year, the trustees directed a committee to spend the money on instruments, but there is no evidence that any purchase was made at that time.[4] With enrollments at an all-time high, the trustees could well bide their time. In July 1805, however, the treasurer's ledger noted that $500 cash was received from the sale of half a township, and in July 1806, this money was spent on scientific instruments. While it is not clear whether the $500 recorded in 1805 was distinct from the profits available in 1804 or just a late entry by the treasurer, it is clear that the Academy began to spend money on scientific equipment in 1806 and was still spending it in 1808, when enrollments had fallen to nearly half the level of 1804.[5] Other benefactors supported Deerfield's buying spree. Colonel Asa Stebbins, for instance, gave a "generous" but otherwise undisclosed amount for the purchase of a planetarium and lunarium in 1806.[6] In short, when it came to procuring apparatus, the trustees' initial performance evidently did not match their benefactors' expectations. In the early years as enrollments climbed, they were slow to build up the school's cabinet of instruments. Later, when enrollments fell precipitously, they picked up the pace. Whether they built up the collection because of falling enrollments or in spite of them, it was remarkable that they held fast to their original vision of Deerfield as a seat of science education. Also remarkable was the range of instruments they purchased. What did they buy, from whom, and why?

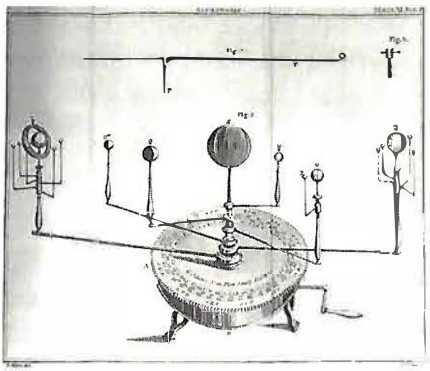
Academic Resources

Although the *Gazette* advertisement first mentioned a large addition of library books, many of which were "particularly calculated to embellish the female mind," pride of place was given to the recent acquisition of "Instruments adapted to the study of Mathematics, and Natural Philosophy."

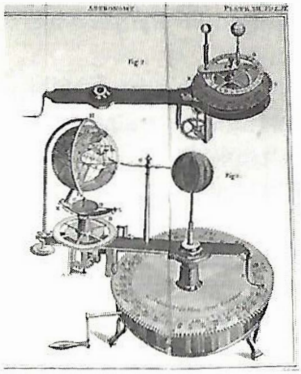
These included:

> An Air Pump with a complete Apparatus for exhibiting the very instructive and pleasing experiments in Pneumatics.
>
> A ten inch best Sextant, and a portable Theodolite, with other instruments adapted to the study of Surveying, Navigation and Astronomy.
>
> A new improved 2½ feet achromatic refracting Telescope, for Astronomical purposes.
>
> A best compound Microscope, with other apparatus for exhibiting experiments in Optics.
>
> An Electrical Machine with apparatus for philosophical experiments.
>
> A pair of twelve inch Globes.
>
> [And shortly expected] a complete Planetarium with Tellurian and Lunarium combined. This Instrument exhibits in the most simple manner, the general phenomena of the Earth, Moon and other Planets; and gives the Student an accurate knowledge of the Copernican System.[7]

The planetarium had not yet arrived from London, and like most of the other apparatus had been purchased on behalf of the Academy by "the scientific *Dr. Prince*, of Salem...[from] the celebrated Mr. Jones, of that City."[8]



Planetarium sold by W. and S. Jones, from George Adams, *Astronomical and Geographical Essays*, 3rd ed. (London, 1795). Smithsonian Institution Libraries.



Tellurian and lunarium attachments for planetarium sold by W. and S. Jones, from George Adams, *Astronomical and Geographical Essays*, 3rd ed. (London, 1795). Smithsonian Institution Libraries.

John Prince (1751-1836) was the minister of the Congregational First Church in Salem as well as an instrument maker who found his calling in equipping colleges and academies with scientific apparatus.[9] His clients included Harvard, Yale, Rhode Island (now Brown), Bowdoin, Dartmouth, Rutgers, Williams, Middlebury, Amherst, Vermont, Union, Transylvania, Tusculum, and the College of Charleston, and academies in Philadelphia, New York, Boston, Byefield, Leicester, Monson, Westfield, and Onondago.[10] Not only was Prince a vendor of scientific instruments designed and built by himself; he also refurbished second-hand apparatus for resale or trade, and he repaired broken instruments. Moreover, Prince had a business relationship with the well-known London firm of W. and S. Jones (fl. 1791-1859), having been recommended to William Jones by Thomas Jefferson in 1786.[11] For nearly forty years, Prince corresponded with brothers William and Samuel Jones on the design and improvement of scientific instruments, and a number of his suggestions were incorporated in the instruments sold by the firm. Although Prince built and sold his own apparatus, he often purchased the most popular scientific instruments from W. and S. Jones for resale to American academic institutions and individuals on short notice. In addition to keeping this modest inventory, Prince acted as the agent for many American schools, selecting apparatus on their behalf and having it shipped from London.[12]

How John Prince became linked to Deerfield is unclear, but the alliance was perhaps inevitable. Nine of the Academy's founders were educated at Harvard, Yale, Princeton, or Dartmouth, and six received honorary degrees from Brown, Dartmouth, and Williams. The school's first two preceptors were Yale graduates, and two granddaughters of Ezra Stiles, the president of

Yale College (1788-1795), were Deerfield pupils during the spring and summer quarters of 1808 and 1809.[13] As mentioned above, Prince sold instruments to every one of these colleges. Moreover, an original Deerfield trustee and principal of the committee to procure philosophical apparatus was John Williams, Esq., a prominent merchant with both family and business connections in Salem.[14]

John Prince, from *American Journal of Science and Arts* 31 (1837). Smithsonian Institution Libraries.

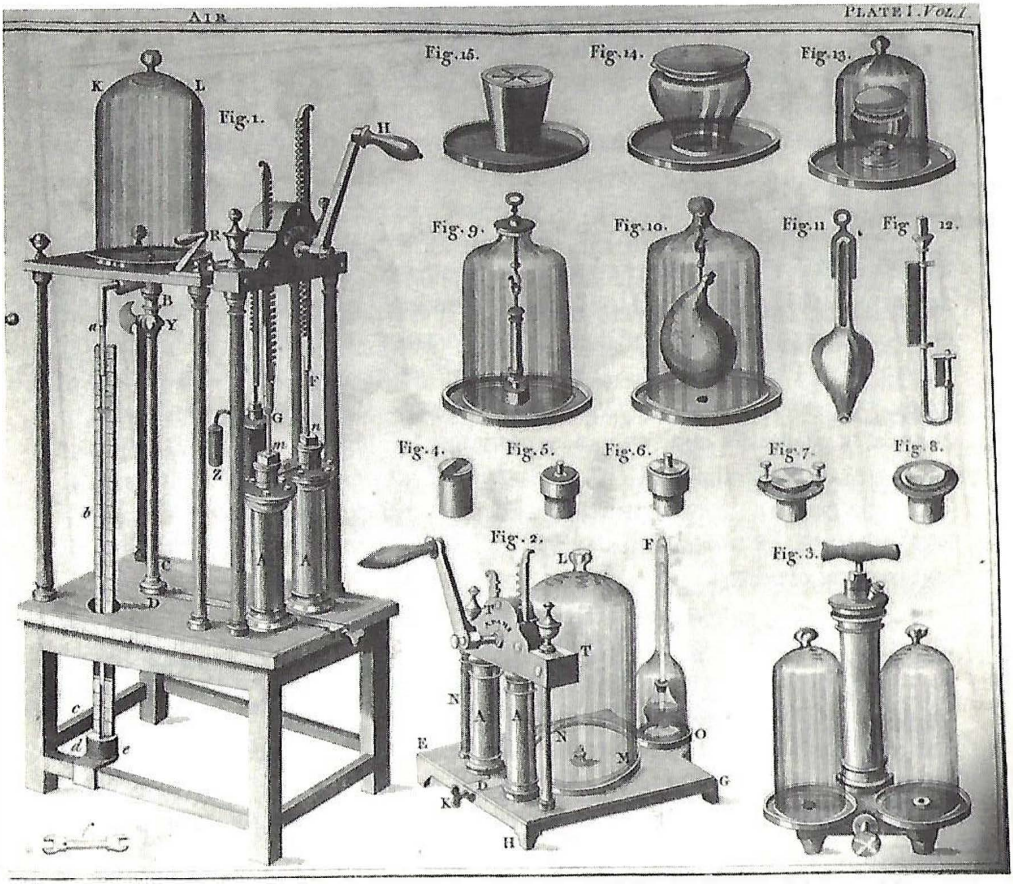
The instruments Prince purchased for the Deerfield Academy between the years 1806 and 1808 are revealing in five respects.[15] First, they spanned the major fields of natural philosophy—namely, pneumatics, astronomy, optics, natural history, matter theory, electrostatics, and cosmography. This affirms that Prince understood the needs of general-science educators and made sure that all topical bases were covered. (The only omission was chemistry, but this subject had a precarious foothold in U.S. academic programs prior to the 1820s.[16] Chemistry fared no better at Deerfield: In 1807, the Academy's trustees unsuccessfully petitioned the General Court of Massachusetts for money to establish and support an instructor of chemistry and materia medica.[17])

Second, many instruments were representative of the types improved by Prince. Distinguished among these was the air pump. In 1785, Prince had published a radical new design for a double-barreled air pump in the *Memoirs of the American Academy of Arts and Sciences.*[18] News of his improvements reached the London instrument maker, George Adams the younger (1750-1795), who began to manufacture and sell "the American double-barrelled air-pump," which he praised as the "most perfect" of pumps.[19]

Curiously, W. and S. Jones initially did not share Adams' enthusiasm for the new design. Thomas Jefferson had met William Jones in London in

March or April 1786 and had given him a description of Prince's new air pump with the hope that he would manufacture it. In November, Jones wrote to say that the press of business had kept him from further investigating the principle and action of the air pump, but so far he had found the design to have no merit:

> I recollect some time back, that myself and two or three ingenious Mechanics, had agreed that the Friction, unavoidably attending the acting parts, would totally destroy the feasibility of the effect of the Machine. I have once since almost experienced it in the construction of a Condensing Syringe made for a Gentleman, something, or rather greatly similar to the plan of that Pump.[20]



American-style air pump (*on left*) and related apparatus sold first by George Adams and then by W. and S. Jones, from George Adams, *Lectures on Natural and Experimental Philosophy* (London, 1794). Smithsonian Institution Libraries.

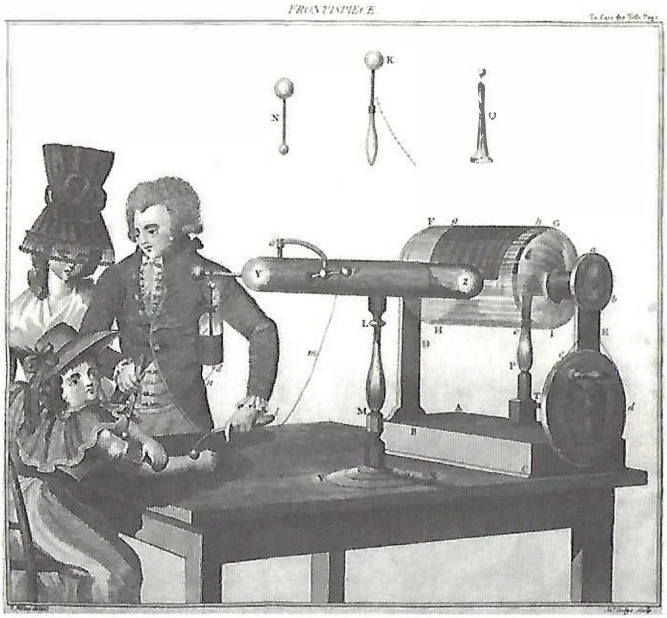
Annoyed, Jefferson began to wish he had communicated the plans to Edward Nairne instead of Jones and asked "Mr. Paine (Common sense)" to withdraw the technical drawings from Jones. Jones realized his big mistake by the time he took over Adams' trade, and he became very solicitous of Prince.[21] In the tradition of Adams, W. and S. Jones continued to sell pumps of the Prince form, and shipped one to Harvard in 1804.[22] An air pump was the first instrument that the Deerfield trustees were impelled to buy, its purchase being the reason for a bequest in 1798.[23] The air pump shipped to the Academy a few years later was no doubt an "American model" made by W. and S. Jones, if not built by Prince himself.

We do not know what type of compound microscope was acquired by Deerfield, but we do know that Prince made major improvements to several types, including the lucernal microscope, solar microscope, and megaloscope. Not only did Prince sell many microscopes directly to schools over the years, he also collaborated with the major London instrument-making firms. For instance, in the early 1790s, Prince developed a new form of lucernal and sold one to Harvard. He described his refinements in several letters to George Adams, whose father had invented the lucernal, and Adams began to sell Prince's improved design. Although Adams concealed his debt to Prince, others knew to whom praise was due. William and Samuel Jones told Prince that like the air pump, the lucernal owed its "present state of perfection and improvement" to him.[24] The Jones brothers were also ready to take advantage of the "very useful and ingenious emendations" Prince had made to other optical apparatus in late 1790s and early 1800s, offering their customers an improved magic lantern and astronomical lantern slides that projected moving images of the planets.[25] Perhaps these instruments were included in the "other apparatus for exhibiting experiments in Optics" that accompanied the compound microscope shipped to Deerfield, Massachusetts on Prince's instruction.

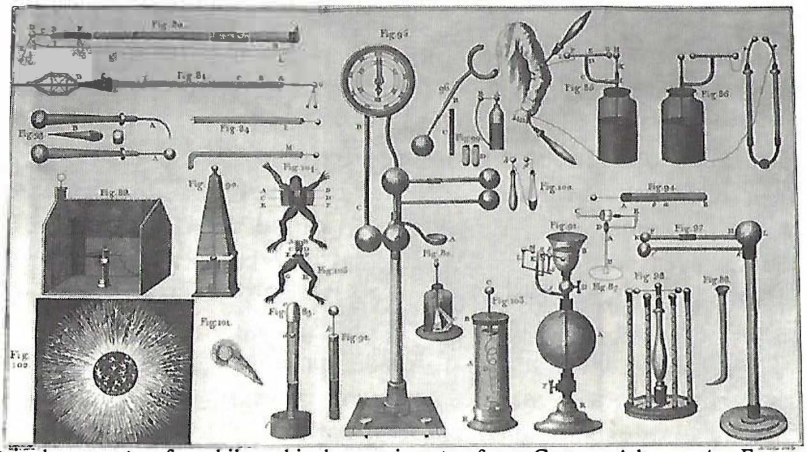
In the 1790s, Prince also improved electrostatic equipment, including Leiden-jar batteries and electrometers, and is known to have offered these directly to his customers.[26] Throughout his career, Prince repaired many telescopes, and as early as 1795, he began to experiment with different telescope stands. He advised Harvard on the mounting of its telescopes, and in 1831 published an account of a new, sturdy mount.[27]

Thus, the Deerfield purchase included pneumatic, optical, electrical, and astronomical apparatus, and these were the categories of instruments that Prince not only made and repaired, but also developed. This relationship may indicate nothing more than the fact that Prince's work covered the gamut of natural philosophy, but I believe it is suggestive of the synergy between his

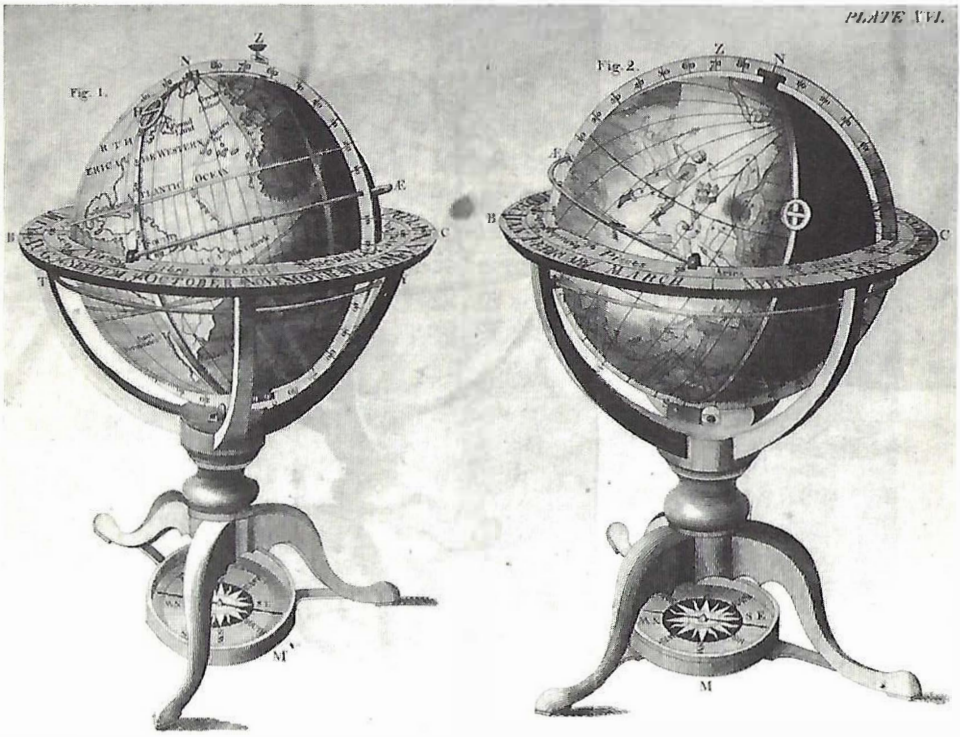
instrument-making activities and his marketing interests.



Electrical machine, from George Adams, *An Essay on Electricity*, 5th ed. rev. by William Jones (London, 1799). Smithsonian Institution Libraries. W. and S. Jones also sold plate machines-an instrument of this sort was used at Kings College (now Columbia University) in New York City, and is now in the collections of the National Museum of American History-but Prince seems to have favored the cylinder machine, as shown here.



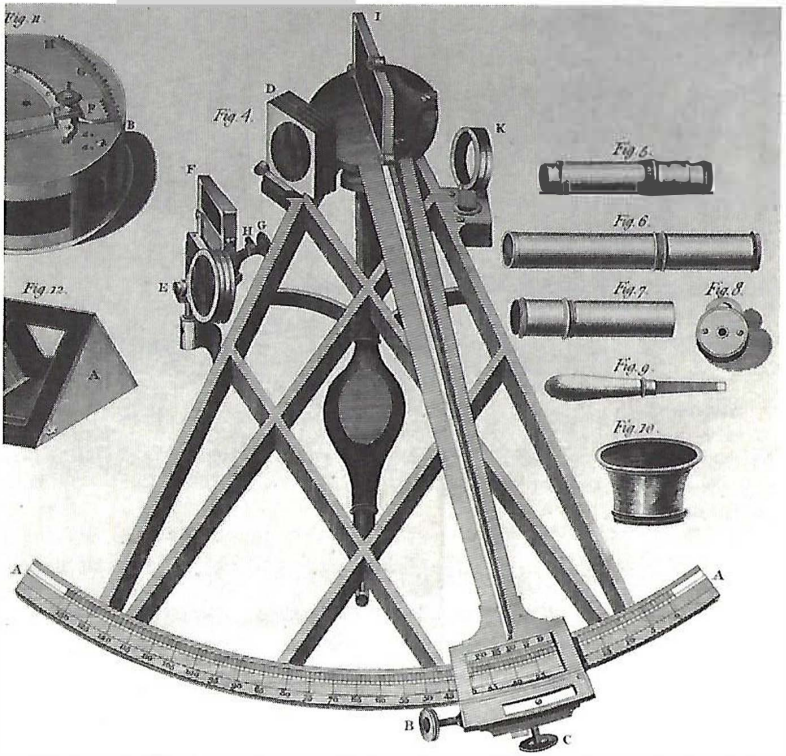
Electrical apparatus for philosophical experiments, from George Adams, *An Essay on Electricity*, 5th ed. rev. by William Jones (London, 1799).



Terrestrial and celestial globes sold by W. and S. Jones, from George Adams, *An Essay, on the Use of the Celesial and Terrestrial Globes*, 4th ed. (Philadelphia, 1800). Smithsonian Institution Libraries.

The Deerfield order is noteworthy in a third respect. Although some instruments (such as the celestial and terrestrial globes, planetarium, tellurian, and lunarium) were strictly pedagogical, others were of research calibre. Proof is found in the early career of Edward Hitchcock (1793-1864), the future state geologist of Massachusetts, professor of chemistry and natural history and later president of Amherst College.[28] Hitchcock was but a rural school boy when he first encountered Deerfield's rich store of apparatus. He spent six winter terms at Deerfield Academy between 1804 and 1809, where his maternal uncle, Epaphras Hoyt (1765-1850), taught military arts and sciences.[29] It was not long after the Academy acquired its apparatus that we find record of Hitchcock, at age fifteen, observing the meridian altitude of the sun's lower limb and Sirius on January 5 and February 22, 1809. Hitchcock used these observations to compute his latitude, giving a mean value of 42°28'36".[30] These measurements were made during the winter term, and the precision attempted leaves little doubt that Hitchcock was using the Deerfield Academy sextant (or less plausibly, the theodolite). Two-and-a-half years later, on 10 September 1811, after several people from the village had seen a comet, Hitchcock again borrowed from the Academy:[31]

a ten inch best metal Sextant divided by nonius to 30 seconds. The index errors were determined by the mensuration of the suns diameter, and allowed for in all observations with the Sextant....[He also borrowed] a Theodolite furnished with an excellent telescope, spirit level, & vertical arch. These two instruments were made by Jones of London, & imported by the Rev[d] D[r] Prince of Salem.[32]



W. and S. Jones's "best metal sextant," from George Adams, *Geometrical and Graphical Essays*," 2nd ed. rev. by William Jones (London, 1797). Smithsonian Institution Libraries. An instrument of this design, originally owned by Colby College, is now in the collections of the National Museum of American History.

During the months of September through December, Hitchcock collaborated with his uncle Hoyt in observing the Great Comet of 1811. To determine the longitude of Deerfield, they took advantage of a partial solar eclipse on 17 September 1811, timing the first and last contact of the moon's limb against the sun. In this exercise, Hoyt and Hitchcock used the Academy's

> 2½ feet achromatic [telescope], magnifying about 75 times, with a pearl micrometer, made by W. Jones, London.[33]

W. and S. Jones refracting telescope with equatorial mount, from Georgetown University. With a tube of 42½ inches, it is slightly larger than the Deerfield Academy instrument. This telescope is now in the the National Museum of American History.

The Academy apparently had no astronomical clock, so they borrowed a "very good metal clock, with a second hand." To regulate the timepiece, they used the school's sextant to observe equal altitudes of the sun's lower limb on successive days. Hitchcock employed it again to double-check their longitudinal measurements by means of the lunar-distance method. Magnetic variation was studied with the theodolite taking altazimuth readings of the sun and Alioth.[34] The observations of the comet, eclipse, stars, and variation were submitted in a scientific report to John Farrar, Professor of Mathematics and Natural Philosophy at Harvard College, and Farrar published an extract under Hoyt's name in the *Memoirs of the American Academy of Arts and Sciences* of 1815.[35]

Hitchcock's and Hoyt's astronomical undertaking tells us a good deal about the research quality of Deerfield's sextant, theodolite, and telescope. To be sure, Deerfield did not have a fixed observatory, but no institution in the United States had one until the mid-1830s.[36] And yes, the apparatus was incomplete—a good clock was needed—but this omission, which in retrospect seems bewildering, highlights just how good the rest of the equipment was. The apparatus certainly was not top of the line, but it was not rock bottom either. Moreover, it is possible that the Academy's air pump, microscope, and electrostatic machine were of comparable quality and could have been used for low-level research if the instructors or students of Deerfield were so inclined.

The fourth point to be made about Deerfield's apparatus is that it, no doubt, cost a lot of money. The primary instruments—the air pump, sextant, theodolite, telescope, microscope, electrical machine, globes, and planetarium—were not cheap by themselves. Moreover, they rarely stood alone. Over and over in the advertisement, we read phrases such as "with a complete Apparatus for exhibiting the very instructive and pleasing experiments in..." or "with other instruments adapted to the study of...." What were these accessories? We can unpack these catchall phrases by examining other school orders processed by John Prince during the same period. For example, his standard packages of electrical apparatus included from twenty to thirty-five items (namely, articles such as a jointed discharger, insulating stool, thunder house, electrometer, and so forth).[37] From Prince invoices, W. and S. Jones trade catalogues, and the surviving (but elliptical) records of Deerfield's treasurer, I estimate that the Deerfield apparatus certainly carried a price tag well above five-hundred dollars and possibly just below a thousand dollars.[38] To put this in perspective, the preceptor—the *sine qua non* of the Academy—was paid an annual salary of $433.33 in the early 1800s.[39] We can also compare the estimated cost of Deerfield's apparatus with the tuition the school charged its students. Until October 1807, the quarterly fees were $2.00 for instruction in reading, writing, and English grammar, and $2.50 for any other branch of literature. Once the apparatus arrived, the fees were raised to the levels advertised in the *Greenfield Gazette*:

> The terms of instruction are as follow, viz.
>
> Reading, Writing and English Grammar, or either of them. Two Dollars and Fifty Cents: Common Arithmetic and Geography, or either of them, Three Dollars: Any other branch of the Arts or Sciences Four Dollars a Quarter.[40]

In 1808, the total enrollment was 137, with half of the students paying below three dollars. These term bills reflected not only the course fees, but also the students' share of the school's operating expenses. That year, the Academy collected $406.94 as compensation for tuition, fuel, and contingent expenses combined.[41] Any way we add it up, Deerfield's scientific apparatus represented a considerable investment on the part of the school and not one easily recouped from tuition. This investment underscores the importance the school's trustees placed on the study of natural philosophy.

The fifth and last point to be inferred from the apparatus is that it was comparable to that purchased by contemporary colleges from John Prince.

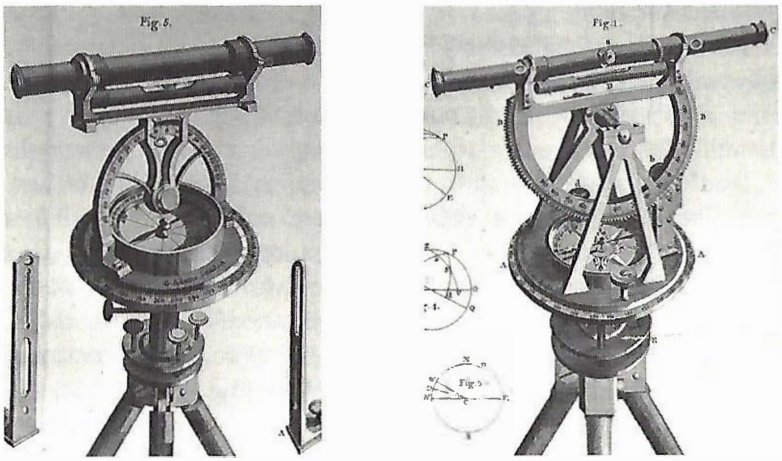
This raises questions about the mission of the Academy. With these scientific resources was Deerfield similar to other academies? Did it strive, like a grammar school, to prepare students for college, or did it aim to rival the colleges? And if Deerfield was a rival, did it compete with colleges on its or their own terms?

Instructional Goals

The answers to these questions are partly to be found in the *Greenfield Gazette* advertisement itself. After mentioning the library and detailing the scientific apparatus, the advertisement continued:

> The Trustees flatter themselves that, with these advantages united with the abilities and fidelity of the Instructors, young Ladies will have an opportunity of acquiring those accomplishments, which peculiarly adorn them; and young Gentlemen (particularly those who wish to avoid the expence of a collegiate course) will be enabled to acquire an education much superior to what they can reasonably expect at any literary Institution in the vicinity, and in what relates to practical utility, or the butsiness [sic] of real life, perhaps equal to what they can obtain at any of the Colleges.

The "business of real life"—a phrase to be found in the charters of many academies—has been rightly noted by historians of education as the pedagogical wedge that separated the early academies from the colleges.[42]



Two portable theodolites sold by W. and S. Jones and matching the description of Deerfield's instrument, from George Adams, *Geometrical and Graphical Essays*, 2nd ed. rev. by William Jones (London, 1797). Smithsonian Institution Libraries.

Benjamin Franklin was among the first to attack the classical curriculum taught to young people in colonial grammar schools and colleges, arguing that too much emphasis was placed on ornamental learning. In 1749, he called for the creation of an academy that would educate Pennsylvania students not only in Latin and Greek but also in practical subjects, such as mechanics, agriculture, and the English language. He envisioned a program that would prepare a student for college entrance or for a career in business and trade, depending on the boy's or parents' wishes.[43] Nevertheless, the classical tradition remained strong until the 19th century, when Franklin's proposals for utilitarian instruction came to fruition in what's known as the academy movement.[44]

Most of the newly-established academies were privately-controlled, educational institutions supported largely by tuition payments and partly by public funds. They were designed to meet the needs of the burgeoning middle class, whose youngsters did not aim to become ministers, planters, or merchants of the first rank. Although some academies continued to offer classical instruction, many focused their attention on modern languages, moral philosophy, science, and practical mathematical subjects, such as surveying, navigation, dialling, and bookkeeping. When an academy included a "female department," it usually emphasized needlework, painting, and other refinements.[45] In this respect, the Deerfield Academy's curriculum was typical, including reading, writing, and English grammar, arithmetic, geography, natural philosophy, surveying, navigation, astronomy, the art of war, and subjects such as cartography, drawing, painting, and embroidery that would embellish the female mind and train the female hand.[46]

Whereas Franklin had envisioned the academy as a potential way-station between the Latin grammar school and the college, antebellum academies like Deerfield should not be viewed as such a secondary link. Until the mid-19th century, a grammar-school graduate could go straight to college, and both academies and colleges admitted students at the age of fourteen or fifteen. In this sense, the academy and college were parallel, and to a degree rival, institutions. The academies leaned heavily towards the practical arts, while the colleges inclined towards the classical subjects.[47]

Historians have claimed that during the second quarter of the 19th century, the academies put pressure on the colleges to teach more modern disciplines, first to keep up their enrollment and later to justify their existence as seats of higher learning surpassing the academies. To this end, college administrators began to weigh the advantages of raising their entrance requirements and expanding their curricula to include political economy, modern languages, and more advanced sciences.[48] Change came at varying

rates to diverse institutions, but was discernable in most by mid-century. As one observer noted in 1851:

> There have been added to the list of college studies chemistry, geology, mineralogy, botany, political economy, and the modern languages; while the departments of mathematics, intellectual and natural philosophy, have been greatly enlarged....In 1801, the quantity of apparatus was very small, and the experimental lectures of the professors very meagre; now almost every college is able to illustrate all the principles of the sciences very fully and to show their practical application.[49]

This suggests that the social forces that had brought the academies into prominence at the turn of the 19th century were now being brought to bear on the colleges as well. According to this historiographic interpretation, academies were the vanguard of educational reform, for they were the first to offer modern languages, social studies, and science—even if only at elementary levels—to a public clamoring for more practical training.

The Deerfield curriculum with its emphasis on the English language, military arts, natural philosophy and practical mathematics (e.g., navigation and surveying) at first seems to support this view. And it may well be that academies such as Deerfield demonstrated to colleges that there was a demand for training in modern languages and moral philosophy. The historical record, however, is equivocal with respect to scientific instruction. Indeed, it must be noted that the impetus for colleges to teach many modern subjects (including politics and law) began in the late 18th century prior to the height of the academy movement;[50] and this was all the more true for the sciences. Take Yale as an example. In 1734, the college acquired its first scientific instruments (including a telescope, microscope, barometer, and surveying tools), and not long after, its students were tutored in calculus.[51] One hundred years later, when the Yale faculty resolved that modern foreign languages, which were taught in the academies, would not become part of the curriculum in 1828 (in consonance with the traditional bias towards classical learning), they nonetheless noted with pride that the Yale curriculum had not been set in stone: "whole [new] sciences—chemistry, mineralogy, geology, [and] political economy" had joined mathematics and natural philosophy in the last thirty years.[52]

Another way to examine this point is to look at the company Deerfield was keeping. Before the Deerfield Academy made its acquisitions from John Prince, Harvard, Rhode Island College, Bowdoin College, and the University

of Vermont had all sought Prince's counsel, and each had purchased from him hundreds of dollars worth of scientific equipment.[53] It appears, then, that academies like Deerfield were not ahead of the pack when it came to instruction in science, but kept up with the pace being set by the colleges.

How then are we to explain the sudden expansion of the scientific curriculum in American colleges after the 1820s if it was not mainly in response to pressure from the academies? The answer in part might be found in the history of science itself. Throughout the 18th century, scientific studies were not specialized and subdivided into separate disciplines such as mechanics, optics, electricity, geology, and chemistry, but were bundled together in a package called natural philosophy. In the early 19th century, natural philosophy began to fragment into specialized disciplines, and these became the advanced subjects taught by the expanded science faculty in the colleges. It is beyond the bounds of this paper to analyze the degree to which specialization was driven by factors internal to scientific research itself or the degree to which it was reinforced by the disciplinary boundaries college professors began to set up between themselves for intellectual or social reasons. But whichever way we swing the pendulum, I believe it is too facile to say that science instruction became more sophisticated in the 19th century because college trustees—looking over their shoulders at the academies—began to care more about science. Science instruction worldwide had more depth in the later period because the subject itself had become richer and its practitioners more specialized.

Where does this leave us with respect to the apparatus at Deerfield? Perhaps marvelling at the gumption of a rural school that thought its apparatus could level the playing field between it and contemporary colleges. For the most part, Deerfield's students could not afford a collegiate course. Nevertheless, it was the Academy's aim to provide them with "an education...in what relates to practical utility, or the butsiness of real life, perhaps equal to what they can obtain at any of the Colleges." What could be more democratic? Scientific subjects—presumed to be of use to society—were essential to this mission. The high esteem in which they were held is indicated by the willingness of the trustees to lay out a considerable sum of money for apparatus selected by John Prince, the foremost dealer in his day in America.

APPENDIX

We can learn more about the design and cost of the Deerfield apparatus by comparing descriptions in the *Greenfield Gazette* and Hitchcock papers with those to be found in trade catalogues and textbooks published by W. and S.

Jones, and those sold by John Prince to other schools. In some cases, we can identify specific instruments; in others, we can only narrow the field of possibilities. Some Prince invoices are already in print,[54] but relevant portions of W. and S. Jones catalogues are not. To this end, I attach excerpts from two trade catalogues of instruments similar to those sold to Deerfield.

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A Catalogue of Optical, Mathematical, and Philosophical Instruments, Made and Sold by W. and S. Jones, [No. 30,] Lower Holborn, London, (Removed from their old Shop, No. 135, next to Furnival's Inn.) [ca. 1802].[55]

	£.	s.	d.
The new-improved 2½ feet achromatic refractor, on a brass stand, mahogany tube, with two sets of eye-glasses, one magnifying about forty times for terrestrial objects, and the other about seventy-five times for astronomical purposes, packed in a mahogany case	9	19	6
Ditto, ditto, the tube all brass, with three eye-pieces	11	11	0
...			
Compound microscopes improved, from 2*l.* 12*s.* 6*d.* to	5	5	0
New improved universal ditto	6	6	0
Ditto with the most complete apparatus	10	10	0
The new opake and transparent solar microscopes, with improved apparatus, from 10*l.* 10*s.* to	16	16	0
Ditto of a larger size, with additional megalascopic apparatus, from 14*l.* 14*s.* to	19	19	0
The Lucernal Microscope, as improved by *W. Jones*, exhibiting images of opake and transparent objects, by night or day, in a manner singularly pleasing, brilliant, and distinct, with upwards of 100 objects, proper apparatus, patent lamp, &c.	16	16	0
...			
A new set of moveable painted sliders, shewing the fundamental principles of astronomy, with the real and apparent motions and positions of the planets, stars, &c. &c. accompanied by a propre improved lanthorn, complete	13	13	0
[curved mirrors, prisms, and other optical apparatus, from 1*s.* 6*d.* to 21*l.*]			
...			
Theodolites of the common construction, and of the best workmanship, from 4*l.* 4*s.* to	31	10	0
A portable theodolite, with a telescope, level, and vertical arch	7	7	0
Ditto larger, with parallel plates, &c. divided to two minutes	12	12	0
Ditto with rack-work motions, divisions to a minute	22	1	0
...			

Metal [sextant], framed on a principle the least liable to be warped or strained, with adjusting screws, telescopes, and other auxiliary apparatus, the most proper for taking distances accurately, to determine the longitude at sea, &c	12	12	0

[mathematical instruments for surveying and navigation, from 4*s*. to 35*l*.]

...

A complete planetarium, tellurian, and lunarium, all in brass, shewing the motions completely by wheel-work, packed in a portable case	36	15	0

...

The New Twelve Inch British Globes, reduced from the above [eighteen -inch size], being the most recent and correct of any extant, mounted in neat mahogany claw-feet frames,with compasses	5	15	6
Ditto, in common coloured wood frames	3	13	6
Additional price of a compass, and fitting to both globes	0	5	0
A pair of red leather covers for ditto	0	11	0

...

Air-pump of the largest sort, exhausting more accurately, being upon an improved construction	34	13	0

[principal apparatus for air pump, costing from 3*s*. to 3*l*. 3*s*.]

...

Cylinder and Plate Glass Electrical Machines, with conductors and jars, from 2*l*. 12*s*. 6*d*. to	10	10	0
New and much improved ditto, from 3*l*. 13*s*. 6*d*. to	42	0	0
An electrical machine with apparatus for philosophical experiments and medical uses, packed in a box, the cylinder about eight inches diameter, from 9*l*. 9*s*. to	12	12	0

[electrical apparatus, from 1*s*. 6*d*. to 10*l*. 10*s*.]

*****

Of the principal Instruments described in this Work, and their Prices, as made and sold by W. and S. Jones, 30, Holborn, London (1813).[56]

Best complete portable theodolite	11	0	6
Six inch theodolite by rack work and staves	12	12	0
Ditto without rack work, common	8	8	0
Second best 7 or 8 inch theodolite and staves, 16*l*. 16*s*. and	22	1	0

...

Best metal sextant, 8 to 10 inches radius	14	14	0
Brass stand and counterpoise for a ditto	5	5	0

Acknowledgments I am indebted to Tina Cohen, archivist of the Deerfield Academy, for facilitating my use of archival manuscripts and directing me to ancillary sources. I also wish to thank Robert Wilfong for bringing the *Greenfield Gazette* advertisement to the attention of Deborah Warner, who passed it along to me with other useful references.

1. Act of Incorporation, 1 March 1797, Deerfield Academy Trustees' Minute Book, 18 April 1797-19 June 1911, opposite page 1, Deerfield Academy Archives, Deerfield, MA. See also Harriet Webster Marr, *The Old New England Academies Founded before 1826* (New York, 1959), 20; Vera M. Butler, *Education as Revealed by New England Newspapers Prior to 1850* (New York, 1969), 164.

2. *Greenfield Gazette*, 7 August 1809.

3. Register of Students and Tuitions, 1 January 1799-11 April 1810, Deerfield Academy Treasurer's Records, Pocumtuck Valley Memorial Association Library, Deerfield, MA.

4. Minutes, 31 December 1798, 17-18 September 1804, Deerfield Academy Trustees' Minute Book, 15, 17-19, 39; "A Memorandum of that part of the Funds appropriated for the purchasing of a Philosophical Apparatus for Deerfield Academy" (1800-1804), in Bonds, Notes, 1797-1840, Deerfield Academy Treasurer's Records.

5. Ledger entries for 1805-1808, Treasurer's Accounts, 5 February 1799-30 June 1861, Deerfield Academy Treasurer's Records.

6. Minutes, 15 September 1806, Deerfield Academy Trustees' Minute Book, 43.

7. *Greenfield Gazette*, 2 May 1808. The advertisement is dated "*Deerfield, April* 15, 1808."

8. *Ibid.*

9. For details of John Prince's career, see Sara J. Schechner, "John Prince and Early American Scientific Instrument Making," in *Sibley's Heir: A Volume in Memory of Clifford Kenyon Shipton*, ed. Frederick S. Allis, Jr. and Philip C. F. Smith, Publications of the Colonial Society of Massachusetts, no. 59 (Boston, 1982), 431-503. For a note on his personal effects at the time of his death, see Ronald K. Smeltzer, "The Library and Apparatus of John Prince," *Rittenhouse* 1 (1987): 93-101 (although I find the analysis problematic).

10. Butler, *Education*, records newspaper notices for many of these schools.

11. W. and S. Jones was a partnership of brothers William (1762-1831) and Samuel (1769-1859). For details of their instrument-making activities, see Gloria Clifton, *Directory of British Scientific Instrument Makers 1550-1851* (London, 1995), 155. For the connections among Prince, Jefferson, Jones, see William Jones to Thomas Jefferson,

London, 10 November 1786, and Thomas Jefferson to Benjamin Vaughan, Paris, 23 July 1788, in *The Papers of Thomas Jefferson*, ed. Julian P. Boyd (Princeton, 1950-), 10: 515-516, 13: 397-398; William Jones to John Prince, 3 July 1797, quoted in Charles W. Upham, "Memoir of Rev. John Prince, LL.D., late Senior Pastor of the First Church in Salem, Mass.," *The American Journal of Science and Arts* 31 (1837): 201-219, see 206; and Schechner, "John Prince," 450. New light on this connection is shed in the present essay, below.

12. Schechner, "John Prince," 472-475, 477-478.

13. Brian Cooke, "New England Academy Education in the Early Republic," *Historical Journal of Massachusetts* 21 (1993): 74-87, esp. 82; Suzanne L. Flynt, *Ornamental and Useful Accomplishments: Schoolgirl Education and Deerfield Academy, 1800-1830* (Deerfield, MA: Pocumtuck Valley Memorial Association and Deerfield Academy, 1988), 22-25; Amelia F. Miller, "Deerfield Academy: The First Decade," appended to Flynt, *Ornamental and Useful Learning*, 51-52.

14. Minutes, 17-18 September 1804, Deerfield Academy Trustees' Minute Book, 39. Mount Holyoke College Art Museum, *Locks, Stocks, and Barrels: The South Hadley Canal at 200 Years* [exhibition catalogue] (South Hadley, MA: Mount Holyoke College Art Museum, 1996), 18-19.

15. Interpolated from ledger entries for 1806-1808, Treasurer's Accounts, Deerfield Academy Treasurer's Records.

16. For instance, Benjamin Silliman, who was appointed Yale's first professor of chemistry and natural history in 1802, had to take time off to learn his subject before he could offer his first course in 1804. The following year, Silliman went abroad as the college's agent, and did not offer the chemistry course again until 1806, when it became a regular course for seniors. Between 1804 and 1810, John Maclean, nominally the professor of chemistry and natural history at Princeton, repeatedly complained to Silliman that despite his title, he was really expected to teach natural philosophy and had trouble getting approval for a chemistry course. Most colleges did not appoint a chemistry professor until the 1820s and 1830s. See Leonard G. Wilson, "Benjamin Silliman: A Biographical Sketch," in *Benjamin Silliman and His Circle*, ed. Leonard G. Wilson (New York, 1979), 1-10, esp. 3-6; and Stanley M. Guralnick, *Science and the Ante-Bellum American College* (Philadelphia 1975), 99-101.

17. Minutes, 14 April 1807, Deerfield Academy Trustees' Minute Book, 47.

18. John Prince, "An Account of an Air-Pump on a new Construction; with some Observations on the common Air-Pump, and Mr. Smeaton's improvement: In a Letter from the Rev. John Prince to the Rev. Joseph Willard, President of the University of Cambridge. Salem, Nov. 10, 1783," *Memoirs of the American Academy of Arts and Sciences* 1 (1785): 497-519. The air pump pictured and described in these *Memoirs* was

sold by Prince to Bowdoin College before 1803. In 1958, the National Museum of American History acquired it (Smithsonian cat. no. 315,394). The pump's importance is discussed in Schechner, "John Prince," 446, 450-456.

19. George Adams, *Lectures on Natural and Experimental Philosophy*, 2nd ed. corrected by William Jones (London, 1799), 1: 50, plate 1; Thomas Dobson, *Supplement to the Encyclopaedia Britannica, or Dictionary of Arts, Sciences, and Miscellaneous Literature* (Philadelphia, 1803), 3: 36 (quoting Adams).

20. William Jones to Thomas Jefferson, London, 10 November 1786 in *Papers of Thomas Jefferson*, 10: 515-516.

21. Thomas Jefferson to Benjamin Vaughan, Paris, 23 July 1788, in *Papers of Thomas Jefferson*, 13: 397-398. William Jones to John Prince, 3 July 1797; quoted in Upham, "Memoir," 206.

22. Schechner, "John Prince," 455-456.

23. Minutes, 31 December 1798, Deerfield Academy Trustees' Minute Book, 17.

24. William Jones to John Prince, 3 March 1798 and 29 September 1798; quoted in Upham, "Memoir," 207. Concerning Prince's microscopic innovations and their appropriation by Adams, see Schechner, "John Prince," 459-462.

25. William Jones to John Prince, 4 March 1798; quoted in Upham, "Memoir," 207-209, see 207; Schechner, "John Prince," 462.

26. Schechner, "John Prince," 463.

27. *Ibid.*, 456-459, 463, 469, 477, 491-493, 495, 497; John Prince, "Description of a New Stand for a Reflecting Telescope," *Memoirs of the American Academy of Arts and Sciences*, n.s., 1 (1833): 334-337.

28. Hitchcock was preceptor of the Deerfield Academy (1816-1818), Massachusetts state geologist (1830-1833, 1837-1841), professor of chemistry and natural history (1825-1845), professor of geology and natural theology (1845-1864), and president of Amherst College (1844-1854). See Gloria Robinson, "Edward Hitchcock," in *Benjamin Silliman and His Circle*, 48-83; Clark A. Elliott, *Biographical Dictionary of American Science: The Seventeenth through the Nineteenth Centuries* (Westport, CT and London, 1979), 126-127.

29. Jordan D. Marché II, "Edward Hitchcock's Promising Astronomical Career," *Earth Sciences History* 12 (1993): 180-186, see 181.

30. Edward Hitchcock MS, Hitchcock Family Papers, box 2, folder 9, Pocumtuck Valley Memorial Association Library, Deerfield, MA; details cited in Marché, "Edward Hitchcock's Promising Astronomical Career," note 2.

31. Edward Hitchcock, "Astronomical Observations on the Comet of 1811/12. On the variation of the Magnetic needle; and for setting the Latitude & Longitude of Deerfield," President Hitchcock Papers, box 10, folder 2, fols. 32-62, see 32-33, Amherst College Archives; manuscript quoted in Marché, "Edward Hitchcock's Promising Astronomical Career," 181.

32. Edward Hitchcock, "Astronomical Observations made at Deerfield (Massachusetts) on the Comet of 1811; with others for ascertaining the Variation of the Magnetic Needle, and determining the Latitude & Longitude of that village," President Hitchcock Papers, box 15, folder 6, fols. 1-2, Amherst College Archives; quoted in Marché, "Edward Hitchcock's Promising Astronomical Career," 181, who cites similar, earlier manuscripts as well.

33. Epaphras Hoyt, "Astronomical Observations Made Near the Centre of the Village of Deerfield, Massachusetts," *Memoirs of the American Academy of Arts and Sciences* 3 (1815): 305-307, see 305.

34. *Ibid.*; Marché, "Edward Hitchcock's Promising Astronomical Career," 183-184.

35. Hoyt, "Astronomical Observations."

36. David F. Musto, "A Survey of the American Observatory Movement, 1800-1850," *Vistas in Astronomy* 9 (1967): 87-92; W. C. Rufus, "Astronomical Observatories in the United States Prior to 1848," *Scientific Monthly* 19 (1924): 120-139; Howard S. Miller, *Dollars for Research: Science and Its Patrons in Nineteenth-Century America* (Seattle, 1970), chap. 2; Nathan Reingold, ed., *Science in Nineteenth-Century America* (Chicago, 1985), 134-139; Deborah Jean Warner, "Astronomy in Antebellum America," in *The Sciences in the American Context: New Perspectives*, ed. Nathan Reingold (Washington, 1979), 55-75; Sara Schechner Genuth, "From Heaven's Alarm to Public Appeal: Comets and the Rise of Astronomy at Harvard," in *Science at Harvard University: Historical Perspectives*, ed. Clark A. Elliott and Margaret W. Rossiter (Bethlehem and London, 1992), 28-54, esp. 39-43.

37. Schechner, "John Prince," 489-502.

38. For Prince invoices, see Schechner, "John Prince," 489-502. A good starting point, if not complete list of W. and S. Jones trade catalogues is R. G. W. Anderson, J. Burnett, and B. Gee, *Handlist of Scientific Instrument-Makers' Trade Catalogues 1600-1914* (Edinburgh, 1990). I have consulted five W. and S. Jones trade catalogues, four of which were appended to publications by George Adams. Excerpts from two catalogues relevant to this study are given in the Appendix. They are dated 1802 and 1813. For the

conversion of British sterling into U.S. dollars, I have used the following historical exchange rates as benchmarks: £24.19.0 = $83.33 (August 1802); £45.00.0 = $200.00 (January 1821). These give rates of 3.34 and 4.44 dollars to the pound. My sources are two Prince invoices: "Acc[t] of Articles taken of D[r] Fobes by D[r] Prince for New Apparatus-with Receipt for the Money for the same. 1802," MS. 1-E-B81mi, vol. 2, fol. 225, John Hay Library, Brown University; Accounts for January 1821, in "Library Catalogue and Philosophical Apparatus, 1793-1814 [sic]," Williams College Library.

Prince is never mentioned in the Deerfield treasurer's accounts, but neither is any other vendor. Payments are made to a "Committee for purchasing Philosophical Apparatus" or to trustee John Williams, Esq., a member of this committee. These payments total $530. There are, however, many more payments to Williams and other members of the committee. Like most lines in the ledger, no purpose is given beyond the date of the invoice submitted. Some of these payments may well have been for apparatus, but others no doubt were for unrelated projects managed by the same trustees. Reports of the trustees' meetings also make it clear that the Academy planned to use donations and the proceeds arising from gifts of land for the purchase of instruments. The above sum included some of the donations, but not all. See "A Memorandum of that part of the Funds appropriated for the purchasing of a Philosophical Apparatus for Deerfield Academy" and "Appropriation of the Proceeds of the Donations on the Opposite Page" (1800-1804), in Bonds, Notes, 1797-1840, Deerfield Academy Treasurer's Records; ledger entries for 1805-1808, in Treasurer's Accounts, which are also part of the Deerfield Academy Treasurer's Records; minutes, 31 December 1798, 8 April 1803, 17-18 September 1804, 15 September 1806, Deerfield Academy Trustees' Minute Book, 17-19, 36, 39, 43.

39. His salary was raised to $500 in 1807. Minutes, 8 April 1803 and 14 April 1807, Deerfield Academy Trustees' Minute Book, 35, 46.

40. Minutes, 9 October 1798, 15 September 1806, 5 October 1807, Deerfield Academy Trustees' Minute Book, 10, 44, 48; *Greenfield Gazette*, 2 May 1808.

41. Register of Students and Tuitions, and Treasurer's Accounts, Deerfield Academy Treasurer's Records.

42. See for instance, the charter of Phillips Academy in Andover, Massachusetts, 1778; quoted in Adolphe E. Meyer, *An Educational History of the American People* (New York, 1957), 130.

43. Benjamin Franklin, *Proposals Relating to the Education of Youth in Pensilvania* (Philadelphia, 1749); *Idem*, "Idea of the English School, Sketch'd Out for the Consideration of the Trustees of the Philadelphia Academy," in *The American Legacy of Learning: Readings in the History of Education*, ed. John Hardin Best and Robert T. Sidwell (Philadelphia, 1967), 80-84; John Hardin Best, ed., *Benjamin Franklin on Education* (New York, 1962), 123-174; and Clarence J. Karier, *The Individual, Society, and Education: A History of American Educational Ideas*, 2nd ed. (Urbana and Chicago, 1986), 33-34.

44. Fifteen academies were opened in Massachusetts by 1797; fifty-five in Pennsylvania between 1784 and 1819; and almost one thousand in the United States by 1830. See Guralnick, *Science and the Ante-Bellum American College*, 22.

45. Marr, *Old New England Academies*; Newton Edwards and Herman G. Richey, *The School in the American Social Order*, 2nd ed. (Boston, 1963), 244-251; Karier, *Individual, Society, and Education*, 70; Meyer, *Educational History*, 129-130; Butler, *Education*, 158-205; Best and Sidwell, *American Legacy of Learning*, 102-103.

46. *Greenfield Gazette*, 2 May 1808; Flynt, *Ornamental and Useful Accomplishments*.

47. Around the turn of the 19th century, academies admitted many students at age ten and sometimes as young as eight. Most of Deerfield's students were in their teens, but the ages ranged from ten to thirty. Academies became a secondary-school link during the period of 1840-1870, when colleges raised their entrance requirements to age seventeen and eighteen. Marr, *Old New England Academies*, 90-91; Karier, *Individual, Society, and Education*, 70; Flynt, *Ornamental and Useful Accomplishments*, 12.

48. Guralnick, *Science and the Ante-Bellum American College*, chap. 2; Meyer, *Educational History*, 131.

49. Emerson Davis, *The Half Century* (Boston, 1851), 7; quoted in Guralnick, *Science and the Ante-Bellum American College*, x.

50. Meyer, *Educational History*, 131-134.

51. Guralnick, *Science and the Ante-Bellum American College*, 11.

52. *Report of the Course of Instruction in Yale College; by a Committee of the Corporation and the Academical Faculty* (New Haven, 1828), 6; quoted in Guralnick, *Science and the Ante-Bellum American College*, 31; and Karier, *Individual, Society, and Education*, 70.

53. Schechner, "John Prince," 489-500.

54. *Ibid.*, 489-502.

55. Fourteen-page catalogue bound with George Adams, *An Essay on Electricity*, 5th ed. revised by William Jones (London, 1799), and a sales catalogue of books dated 30 May 1802.

56. Pages 532-534 of George Adams, *Geometrical and Graphical Essays*, 4th ed. corrected and enlarged by William Jones (London, 1813).