

Chapter 9

High-School Courses

There is a long and honorable tradition of teaching astronomy in American high schools, a tradition whose history is discussed in the first two papers of the chapter. We read about the “ups” and “downs” of astronomy in the curriculum and some possible historical reasons. We see that it is important for astronomers to be included in broad curriculum planning. An interesting discussion follows this first pair of papers. The next chapter discusses a current project to improve high-school science teaching using astronomy as a base. Finally, we read about astronomy teaching on the high-school level in West Germany, Japan, and Bulgaria.

HISTORY OF THE TEACHING OF ASTRONOMY IN AMERICAN HIGH SCHOOLS

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Early American colonists had a deep interest in astronomy. Between 1725 and 1764, Nathaniel Ames published the *Astronomical Diary and Almanac* at Cambridge, Massachusetts. This was a brief, widely-circulated source of astronomical information. It averaged an amazing 60,000 sales per year, while the better known *Poor Richard's Almanac* distributed only about 10,000 per year (Noble, 1970).

Practical skills were the dominant theme in early colonial schools. The astronomy that was taught dealt with natural phenomena such as phases of the moon, eclipses, and, for practical purposes, navigation and time-keeping. Astronomy was also frequently taught as a part of what we today would call physical geography courses. This practical nature of our culture dominated American schools until about the middle of the 1800's. Astronomy, as a separate subject, did appear in the curriculum of academies — forerunners of the modern American high school. A popular textbook of this period, *An Easy Introduction to Astronomy For Young Gentlemen and Ladies*, by James Ferguson, dated 1817, illustrates this point. It is almost completely devoted to the explanation of natural phenomena (Ferguson,

1817). It is a charming book, taught in classic dialogue form between the teacher and his students.

Specialized teacher-training institutions began in the United States in 1839. These were designed primarily to prepare elementary school teachers. A course of study included: orthography (spelling), reading, grammar, composition and rhetoric, logic, writing, drawing, arithmetic (mental and written), algebra, geometry, bookkeeping, navigation, surveying, geography (ancient and modern with chronologies, statistics, and general history), physiology, mental philosophy, music, constitution and history of the United States, natural philosophy and astronomy, natural history, the principles of piety and morality common to all sects of Christians, and the science and art of teaching. Commonly this was a one-year or, at most, a two-year program (Hinsdale, 1900).

The educational philosophy of “mental discipline” determined curriculum and teaching procedures during the second half of the nineteenth century, just as the influence of the common practical culture had exercised a dominant role during the first half. During the first half of the century, newer subjects such as astronomy entered into active competition with the classics. Conservative scholars decried these new subjects as too simple and poorly organized to meet the requirements of “mental discipline.” This competition reached an acute stage near the middle of the century when a fierce controversy broke out in Great Britain between a group of brilliant scientists, on one side, and representatives of the great English public schools, on the other. The classicists maintained that the sciences were “shallow information subjects, lacking in organization, unsuited for discipline and altogether unworthy of the efforts of a high-minded school” (Noble, 1970). Faraday argued on behalf of the study of physical sciences for developing judgment skills and Lyell offered testimony to their contribution to the development of perception and reasoning powers. The scientists won, but the result was the emergence of science courses which began to take on “rigor” to the exclusion of simple phenomena. This “toughening-up” was designed to meet the requirements for “mental discipline.” To illustrate the nature of the effect of this change, Burritt’s popular *Geography of the Heavens*, published at the middle of the 19th century, still reflects a practical, observational approach (Burritt, 1854). Young’s *Lessons in Astronomy*, published in 1895, takes on the rigorous appearance of more modern texts (Young, 1897).

I shall leave to Dr. Bishop (see the following paper) to discuss the effect of the “Committee of Ten,” but I will share with you one set of science enrollment figures for American public and private high schools during the 1890’s. These figures show that astronomy was taken by only about 4% of the students, geology by about 5%, chemistry by 9%, and physics by 20%. (“mental discipline,” you know.) One should also keep in mind that many of the courses were not the standard year-long high school courses, as we know them today.

I personally believe that the figures generally represented the status of astronomy as a separate subject prior to the effects of the “Committee of Ten” and do not represent the immediate effect of the actions of the committee. I failed to locate any national figures prior to that year in the Harvard Library so I would be happy

to be proven wrong on this point.

Table 1. Selected Science Course Enrollments in Public and Private High Schools and Academies during 1897-1898^a.

Subject	Enrollment	Percent of Total
Astronomy	24,433	4.40%
Chemistry	47,448	8.55%
Geology	25,851	4.66%
Physics	113,650	20.48%

^a(Butler, 1904)

I do not dispute the ultimate effect of the committee's work. By 1920, astronomy had largely disappeared as a separate subject in American schools. A survey of high school curricula during the 1860's revealed that 14 schools in a sample of 20 taught astronomy. A similar survey done in 1915 showed only 1 astronomy course offered in the 40 schools sampled (Packer, 1924).

Dr. Bishop and I also differ strongly on the reasons for the re-emergence of astronomy as a separate subject in American high schools during the 1960's and '70's. I believe she would argue that the new availability of the relatively affordable planetarium dictated astronomy's re-emergence. I argue that cultural relaxation and the spirit of an "open society" during that period produced this re-emergence. While she may be right, I have the advantage of having been a member of the school and university setting at the time, and observed these changes first-hand. I do admit that I can supply no empirical evidence to support my view.

In the United States, Sputnik produced a cry for curriculum reform in schools during the early 1960's. One example of the nation's response to this crisis was the development of the Earth Science Curriculum Project, or ESCP, as it was called. This project, sponsored by the American Geological Institute and the National Science Foundation, developed and distributed a set of materials under the title of *Investigating the Earth*. The course is an amalgam of geology, astronomy, meteorology, and oceanography. Earth science, as a high school course, became very popular in the United States. A number of commercial texts were written, emulating its style and content. Currently earth science enrolls about 1.5 millions students annually in the eighth and ninth grades (Welch, 1984). An analysis of the content of the four most popular earth science textbooks currently in use indicates approximately 18% of a typical text is devoted to astronomy.

Prof. Owen Gingerich from the Harvard-Smithsonian Center for Astrophysics played a vital role in the development of another nationally-funded curriculum project, Harvard Project Physics. These materials were designed for a senior-high-school physics course and also included a section on astronomy. It is unfortunate that this text did not retain the popularity it deserved.

The sweeping curriculum reforms of the 1960's also reflected the "open society"

of that time. Teachers were free to experiment with new courses; separate courses in geology, meteorology, oceanography, and astronomy (as well as other science courses) began appearing in the curriculum of American schools. Data obtained by a Project STAR survey reveals that many separate courses in astronomy had their beginning about twenty years ago. Project STAR's data suggests that about 15% of American schools offer a separate astronomy course. We know of approximately 1600 courses. I believe that this figure is a low estimate.

These courses, the survey revealed, are most often taught by a physics teacher. Earth-science teachers are the next most frequent teachers of these separate courses. I recently completed a survey of American earth-science teachers at the Harvard-Smithsonian Center for Astrophysics. Ten percent of the nation's 22,860 earth-science teachers were sent a short questionnaire inquiring about their teaching experience, course load, *etc*¹. Twelve per cent of the respondents reported teaching a separate astronomy course in addition to the regular earth science course. If my results are valid, this would suggest that about 2700 earth science teachers teach a separate course in astronomy, in addition to those being taught by other science teachers.

Table 2. Separate Courses Taught by Earth Science Teachers.

Course	Percent
Astronomy	12%
Geology	10%
Meteorology	4%
Oceanography	3%
No Separate Course	71%

I have a great concern for the formal academic preparation in astronomy for our earth science teachers. I completed another survey three years ago in the state of Iowa. The results of that survey indicate that a third of Iowa's earth-science teachers have no formal preparation at all in astronomy. The average number of semester hours of astronomy in their college background is only about 3 semester hours — or one course (Hoff, 1988). Dr. Weiss' extensive work at the Research Triangle Institute suggests that nationally about 60% of the earth science teachers in the United States have no astronomy or space science college course work in their background (Weiss, 1987).

Clearly, there is considerable work to be done in the United States to improve high school astronomy instruction.

References

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¹Survey conducted at the Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, April 1988.

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Discussion

C. Harper: *The renewed interest in astronomy in the 1960's would seem to be correlated with the development of the U.S. space program.*

THE COMMITTEE OF TEN

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The college-educated populations of colonial 18th- and 19th-century United States were reasonably well-versed in principles of elementary astronomy — perhaps not fully in spatial concepts of seasons and lunar phases, though they certainly had some correct ideas about their causes. Astronomy had found a niche in academies and in the public high schools that succeeded them. In 1838 an observatory was installed in a Philadelphia high school. The states turned to the academies and early high schools for the majority of their elementary teachers, so the teachers who completed high school in the 19th century had been taught the reasons for common astronomical phenomena and conveyed these reasons to children. Parental