

What is Earth Science – The History from Colonial America to Present

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Introduction

While elements of geology, astronomy, physical geography, and environmental sciences were taught in schools at the turn of the century, today's Earth science course is a recent addition to K-12 education. An examination of the development of Earth science provides an understanding of how science courses are introduced, evolve over a period of time, and are replaced by other courses. In establishing the foundations of Earth science education in the American education system, the development of science education was traced in several texts to the time science was formally introduced into schools through the National Education Association's (NEA) Committee of Ten recommendations in 1894.

Education in Colonial America to the Civil War

Early settlers to the North American continent came from a wide variety of countries and brought with them the education systems of their cultures. Religious training and training in the classics were the important subjects of the day. Earliest learning took place in the home (primary school) but this gave way to the "petty or dame school" (Cubberley, 1948) in which women with basic skills in reading and writing would take students into their home. A second type of school, the writing school, taught "writing, reckoning, and...merchants accounting" (Cubberley, 1948). The writing school gradually merged with the dame school to form the school of 3-Rs, "reading, [w]riting, and [a]rithmetic," which became the elementary school of the times (Cubberley, 1948).

The founding fathers of the United States realized the importance of education. In Washington's farewell address (1796) he admonishes the American people to "promote then, as an object of primary importance, institutions of the general diffusion of knowledge." Thomas Jefferson advocated education: "If a nation expects to be ignorant and free, in a state of civilization, it expects what never was and never will be." In 1779, as a member of the Virginia legislature, Jefferson introduced a bill for public education in Virginia. Jefferson proposed a tiered school in which students would have "three years gratis, and as much longer as they please paying for it" (cited in Raubinger, et al, 1969).

In Jefferson's plan the first three years would be devoted to "reading, writing, and arithmetic," then one student ("boy") from each school would be chosen to move on to one of twenty grammar schools for "Greek, Latin, geography, and the higher branches of numerical arithmetic" Under Jefferson's plan "twenty of the best geniuses will be "raked from the rubbish annually and instructed at public expense". After six years of instruction, ten of the twenty would be chosen to continue on to William and Mary College. Jefferson was formalizing the class system of education that many colonists brought from Europe (Raubinger et al, 1969).

Benjamin Franklin railed against the early institutions of education and in 1749 published *Proposals Relating to the Education of Youth in Pennsylvania*. Breaking with the European tradition, Franklin's treatise called for the establishment of schools to teach "useful" subjects such as English, geography, history, natural history, health, astronomy, and agronomy and who should be taught these subjects. Franklin's aim was to establish an institution of higher learning he called an "academy for the education of youth" (Sizer, 1964). Franklin solicited subscriptions and created an academy that ultimately became the University of Pennsylvania.

Franklin's ideas however were not fully followed by his academy and he complained that "Latinists were building their part at the expense of the English school" (Raubinger et al, 1969). Franklin demanded the corporation that financed the academy be dissolved. In 1778 the Phillips brothers, acting on Franklin's ideas, founded academies in Andover, Massachusetts and Exeter, Massachusetts in 1781. These academies and others accepted both male and female students who could pay for their education. This academy plan rapidly expanded, offering a wide range of subject matter. By 1850 there were over 6000 academies in existence (Raubinger et al, 1969).

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By the time of the Civil War, academies were the dominant form of school and became “important institutions of secondary education” (DeBoer, 1991). In following Franklin’s admonition to teach useful subjects, the academies offered science classes in addition to the other subjects and became the first important nineteenth century institutions to promote the study of science (DeBoer, 1991). Science teaching at academies, however, was not always of high quality and often consisted of courses as short as six weeks, with inadequately prepared teachers and poor or non-existent textbooks (DeBoer, 1991 and Sizer, 1964). Because the academies charged tuition there still existed a large block of the population that could not afford schooling.

Earth science civil war to present

At the close of the civil war academies continued to grow and at the end of the last century, with an education system in place, educators turned their work to creating a sequence of courses that would best serve future citizens. The NEA’s Committee of Ten met to establish a norm for the types courses for schools to teach. Not surprising as the committee was composed predominately of university and college faculty that the recommendations were based on the assumption that students would be continuing on to college.

The committee reviewed the recommendations of nine discipline conferences to arrive at a final recommendation. It was resolved at a joint science subject meeting that science should occupy at least 25 percent of the syllabus. The Committee of Ten suggested that physical geography was to be taught at the ninth grade, biology in the tenth, chemistry in the eleventh, and physics in the twelfth. Partially as the result of a report by the U.S. Bureau of Education general science made its way into the curriculum displacing geography and by the 1950s general science occupied a major place in schools at the ninth grade level.

Earth science was introduced as a special class for gifted students in New York as one of the first states along with Pennsylvania to adopt Earth science as part of the state curriculum. By 1964 Earth science was offered in 44 states with over 190,000 students nationwide displacing general science. The Earth Science Curriculum Project, released in 1967, was hailed by some authors as a model of inquiry driven curriculum and set a standard for Earth science education. Unfortunately this growth trend began to wane during the 1980s. Since the introduction of the National Science Education Standards by the National Research Council in 1996 which specifically calls for the inclusion of the Earth and space sciences across the K–12 curriculum there is a resurgence in Earth science offerings nationally.

What is Earth science?

With the development of curriculum and teacher enhancement programs in the 1940s, Earth science had an identity crisis. As the summary prepared for the Ninth International Clearinghouse Report states: “Obviously Earth and Space Science as a distinct discipline does not exist.” (Lockard, 1975). The summary mentions geology, meteorology, astronomy, and oceanography and how they deal with how the “immediate physical environment of man lends itself to an interdisciplinary course” (Lockard, 1975).

This author reviewed a number of writings from the 1950s to 1970s in search of recommendations for Earth science content as part of a dissertation research project. In a series of articles published in geoscience and other literature more than a dozen authors with similar viewpoints, some as early as the 1960s, stated their opinion of earth science course content. These writers listed the disciplines they thought should be included in earth science or listed disciplines they perceived to be part of the definition of earth science education.

Of 14 authors reviewed, only one did not mention the disciplines of meteorology, astronomy, and oceanography now considered to be part of Earth science. Six of the authors recommended geography and five recommended geophysics in addition to geology. Geophysics in the broadest sense of the definition—as listed in American Geophysical Union literature—includes all of the disciplines listed by the 14 authors excepting geography. Geography which was mentioned by several of the authors could be combined into geology, meteorology, and oceanography.

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A listing of 68 recommendations from the 14 authors were combined into common themes to arrive at an ex post facto recommendation for the content of Earth science education. Geology was mentioned 19 times or 27.9 percent, meteorology was mentioned 16 times or 23.5 percent, oceanography was mentioned 16 times or 23.5 percent, and space sciences were mentioned 17 times or 25 percent. If the combined suggestions are followed literally then the content of earth science at the K–12 level as suggested by these authors should include these four basic areas in even proportions.

What is taught in reality? Discussions with teachers reveal anecdotally that a wide variety of opinions exist as to what should be included in Earth science. It has often been suggested that classroom content closely follows text book content. Another section of this author's dissertation research focused on text books with this in mind. Members of the National Earth Science Teachers Association (NESTA) were polled in 1992 as to the most commonly used text books in their classrooms. The results yielded 10 Earth science textbooks published between 1971–1992 in use. The procedures followed to produce the 14 authors' suggestions for the content of Earth science were applied to textbooks' Table of Contents to produce a listing of textbook content by discipline.

The ten textbooks surveyed for this study contained a total of 225 chapters. The chapter titles were coded to match the four disciplines suggested above. Six chapters were of an introductory nature and omitted. The remaining 219 chapters were used to calculate the percentages of space devoted to the four above mentioned disciplines. Of the 219 chapters 120 of them are devoted to geology, 34 to meteorology, 23 to oceanography, and 42 of them to space sciences. This means that if teachers teach from their textbooks as suggested by some authors (Shymansky et al, 1994 and Zahorik; 1991) then geology occupies 54.8 percent of teaching and the other three—meteorology, oceanography, and space sciences—are taught during the remaining 45.2 percent of the time.

Conclusion

The question of what is taught in Earth science classrooms nationwide is still open. The National Science Education Standards and the American Association for the Advancement of Science's Benchmarks for Science Literacy and Science for All Americans are setting new content guidelines for all disciplines. NASA's Earth systems science program is recommending an integrated approach to Earth and space science. The American Geophysical Union recently conducted a workshop with broad NSF support including the Division of Undergraduate Education and the Earth sciences directorate that focused on using a systems approach to undergraduate education. One section of the workshop report (AGU, 1997) deals with teacher preparation and the importance of using a systems approach to education and incorporating the National Science Education Standards into undergraduate classes. As the development of science education in the United States from colonial times to present has shown, what we teach in Earth science and in other disciplines will continue to evolve. As Earth scientists who are taught to follow a multiple working hypothesis we must remain open to suggestions in order to find an answer to this question.

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