SUBJECT MATTER TRENDS IN SCIENCE IN ELEMENTARY SCHOOLS AS SHOWN BY COURSES OF STUDY

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Introduction

There has been considerable written about the shortage of scientists, engineers, and science teachers. Today we live in an age of science. The place to initiate an interest in science for today's youngster is not the high school, but the elementary school. It is the opinion of the author that programs in science in the elementary schools taught by teachers who like science and youngsters will produce enough future science teachers and scientists to provide the needs of future generations. However, the purpose of teaching science in the elementary school is not only to produce science teachers, engineers, or scientists.

Science is so interesting that, when taught by a teacher who is aware of this and who can stimulate and develop the interest of his pupils, it will serve to provide a path which may lead to careers for many of the pupils. However, if science in the elementary school is taught by a teacher who has a fear of it, then many pupils will not be exposed and many may acquire the teacher's fear and dislike.

The increasing awareness of the importance of science in our lives has caused people to wonder about the science curriculum in the elementary school (Dubins, 1957:23). Linus Pauling (1951:52), Chairman of the Chemistry Department at the California Institute of Technology, has stated, "Through experience we have learned that the way to teach mathematics is from the kindergarten up in all grades . . . the time has now come for the study of science to be made a part of the curriculum in every grade, in every level through high school and college . . . only in this way can we train citizens for life in the modern world. Only in this way can we develop a citizenry able to solve the great social and political problems confronting us in this world."

What is the content of the elementary curriculum in science? Has it changed during the last 35 years? What would be a good way to study the science content of the elementary school curriculum for this period? There are different ways of arriving at answers to these questions. One of the best is by means of the course of study which is a guide prepared

by school personnel as an aid for teaching in a given subject or area of study.

Since 1922, periodic analyses of courses of study in science in the elementary grades have been made. Those found in the literature were investigated and the data pertaining to the content of the courses of study in science in the elementary school were carefully studied. The author analyzed courses of study in science in elementary schools prepared from 1940-1952, scattered over the United States. It was necessary wherever possible to regroup the data to have a basis for comparison for the different periods in which the courses of study were prepared.

Elementary Science Courses of Study Previous to 1927

Reinoehl (1922) made one of the earliest, most detailed, and most important analyses of science content in courses of study in the elementary school. His study covers most of the material published from 1910 through 1920 on rural elementary schools. As none of the courses of study included the term elementary science, Reinoehl (1922:32, 88) classified geography, hygiene, physical education, and nature study as categories of elementary science. He listed topics appearing in 80% or more, 60-80%, and 40-60% of the courses of study.

Abstracting from his study the topics which would be taught in an elementary classroom in science today, one finds weather records, soils, air pressure, moisture in the air, winds, clouds, fog, iron mining, day and night, seasons, sun, moon, stars from the earth sciences. These are the only topics from the physical sciences. In nature study and hygiene, which are most closely related to the biological sciences, there are numerous topics. Indeed, these two categories make up most of the science program in the course of study.

Two years after Reinoehl's investigation, Hillman's (1924) research became available. He investigated the science curriculum of the elementary school from a geographic sample of courses of study for 1921 to 1922. Hillman categorized the topics of the science program into plant studies, animal studies, and physical and chemical topics and made a frequency study of them by grade levels in which they were taught.

His overall analysis showed that there was little change in the make-up of the science curriculum from grade one through grade five as three-fourths of the topics were related to animal and plant life and one-fourth to physical and chemical matters. In grade six the emphasis shifted with physical and chemical topics constituting almost half of the topics.

The topics classified by Hillman (1924:23) into physical and chemical with the greatest frequency were as follows: weather observations, snow, soil, frost, wind, clouds, ice, ventilation, thermometer, sun, heating homes, moon, dew, sun position, water, direction, stars and compass. No more than the top 19 have been listed because of the paucity of occurrence of the others. Many of the top 19 items are confined to the primary grades, and several to the intermediate grades.

In order of frequency the top 20 topics related to animal and plant

life were as follows (Hillman, 1924: 18, 19): bird identification, tree recognition, identification of common flowers, seed dispersal, seed germination, seeds, butterflies, dogs, autumn leaves, bird migration, identifying weeds, horses, habits of birds, caterpillars, cats, fruits, gardening, cows, rabbits, and bees.

The Period of Transition

Courses of study in science in the elementary school written between 1930 and 1940 were analyzed for science content by Herbert Bruner and his associates (Bruner, 1941). Unfortunately the content of the primary grades was not investigated.

A reclassification of Bruner's data into topics dealing with plants and animals and those dealing with physical sciences revealed the following:

1. Grade 4 had 56.4% biological versus 43.5% physical science topics.
2. Grade 5 had 59.5% biological versus 40.5% physical science topics.
3. Grade 6 had 31.4% biological versus 68.6% physical science topics.

Those topics dealing with physical science in Bruner's list included: current electricity, earth measurements, light, heat, sound, machines, magnetism and electricity, matter, oxygen and oxidation, scientific methods, and steam. Many of them did not appear in the courses of study written before 1927. Those physical science topics which appeared in the pre-1927 courses of study had a greater frequency of occurrence in the 1930 to 1940 period. By comparing in the intermediate grades the courses of study in the pre-1927 period and the 1930 to 1940 period, it can be readily seen that the number and percentage of physical science topics greatly increased, especially at the sixth grade level.

Alice Gilbert (1943:769 - 773) studied the content of 30 elementary science courses. Her findings were similar to those of Bruner. She found that the fields of science had a greater representation in elementary science in 1943 than in 1924. Her 20 topics with the greatest frequency occurrence rank as follows: protection of birds by man, importance of the sun, ways birds are valuable to man, migration of birds, uses of water, life history of the frog, relation of time units to movement of the earth, life history of the honey bee, factors necessary for plant growth, locations of constellations, movements of the moon, movements of the sun, formation of rocks, life history of the ant, changes in the earth's surface, life history of the butterfly, identification of common garden flowers, green plants make their own food, scattering of seeds, and habits of domesticated animals.

Undoubtedly one of the reasons for the increase of physical science content in the elementary school curriculum was the work of Gerald Craig now Professor Emeritus at Columbia University. In 1927 he developed a course of study in science for the Horace Mann Elementary School which was affiliated with Columbia University. He was a pioneer in breaking away from the bonds of the nature study centered science curriculum of the elementary school of that time. His work had

wide influence and "the results . . . were soon reflected in school curricula throughout the country" (Underhill, 1941:220).

Analyses of Recent Courses in Science in Elementary Schools

Dubins (1953) analyzed courses in science in the elementary school, prepared from 1940 through 1952. The science content for each grade through six was carefully investigated, using as the main instrument a Subject Matter Content Guide. This was devised to provide a numerical, consistent, yet simple means of recording data from which conclusions concerning the subject matter of courses of study in elementary science could be drawn. It is a reference, listing the material being taught in science in the elementary school, the grades in which the material is being taught, and the number of school systems whose courses of study were investigated teaching the subject matter.

The framework is as follows:

Areas and Sub-areas in Elementary School Science

Area 1. *The earth*:—Sub-areas: A, air; B, water; C, composition of earth; D, forces changing earth's surface; E, history of earth; F, weather.

Area 2. *The heavens*:—Sub-areas: A, relation of earth to moon and sun; B, solar system; C, stars and galaxies; D, comets, meteors, and meteorites.

Area 3. *Energy*:—Sub-areas: A, atomic and molecular forces; B, chemical energy; C, magnetism; D, electricity; E, gravity; F, heat; G, light; H, sound.

Area 4. *Living things*:—Sub-areas: A, classification; B, distribution of plants and animals; C, needs; D, how plants and animals obtain food; E, interdependence, dependence, and independence; F, adaptation; G, reproduction; H, growth; I, improvement; J, response to stimuli.

Area 5. *Man's control of his environment*: — Sub-areas: A, man's control over living things; B, man's use of earth products; C, man's use of energy; D, conservation; E, health; F, safety.

Each sub-area is made up of topics, both major and minor, with minor topics occasionally being broken down into other minor topics. The frequency of occurrence of each topic by grade level was determined.

In order to have data which would serve as a basis of comparison with data obtained in analyses of previous courses of study, the frequencies of occurrence of the topics listed were totaled under physical sciences and biological sciences. It is realized that a clear-cut differentiation is not possible. However, as was done in previous studies, topics pertaining to plants and animals were placed in one group and all other topics in another group.

The number of topics dealing with the physical sciences in each grade exceeded the number dealing with the biological sciences. The difference was as much as 10% for each grade up to and including four. For grades five and six there were 17% more topics in the physical sciences.

The emphasis in rank order (Dubins, 1953:466) given the major areas was as follows: earth, 1; living things, 2; man's control of his en-

TABLE 1.—Comparison of Percentages of Topics Dealing with Physical and Biological Sciences in Elementary School Science Courses.

Grade	Biological			Physical		
	1920, Hillman	1930-40, Bruner	1940-52, Dubins	1920, Hillman	1930-40, Bruner	1940-52, Dubins
1	76.0	....	44.2	24.0	....	55.8
2	76.0	....	45.2	24.0	....	54.8
3	73.5	....	44.8	26.5	....	55.2
4	78.2	56.5	45.4	21.8	43.5	54.6
5	70.0	59.5	41.4	30.0	40.5	58.6
6	53.0	31.4	41.5	47.0	68.6	58.5
Totals	72.8	53.6	42.9	27.2	46.4	57.1

vironment, 3; energy, 4; and the heavens, 5.

The emphasis in rank order given the sub-areas (Dubins, 1953:467) was as follows:

1. Weather
2. Adaptation
3. Relation of earth to moon and sun
4. Water
5. Health
6. Composition of earth
7. Growth
8. Air
9. Heat
10. Man's use of energy
11. Conservation
12. Man's control over living things
13. Electricity
14. Light
15. Forces changing earth's surface
16. Interdependence, dependence, independence
17. Classification of living things
18. How plants and animals obtain food
19. Man's use of earth products
20. Stars and galaxies
21. Magnetism
22. Reproduction
23. Needs of living things
24. Safety
25. Solar system
26. Sound
27. Distribution of living things
28. History of earth
29. Atomic and molecular forces
30. Response to stimuli
31. Improvement of living things
32. Gravity
33. Chemical energy
34. Comets, meteors, and meteorites

Dubins (1953:468) found that the 25 most popular major topics in order of frequency of occurrence in the courses of study in elementary science, published from 1940 to 1952, were as follows: sun, moon, role of water in health, heat (weather), weather instruments, wind, sun's role in weather, stars, condensation, plants need water, measurements of heat, properties of water, earth relative to moon and sun, uses of air, constellations, types of precipitation, uses of water, uses of electricity, machines, uses of heat, plants need sunlight, animals' means of protection against enemies, erosion of earth's surface, plant structure, and oxygen.

Most of the studies investigated indicated that there was little agreement among the courses of study as far as the subject matter was concerned. Dubins (1953:465) found that less than 4% of the 476 major topics reoccurred in over half of the 163 grade-courses of study. Slightly less than one sixth of the major topics reoccurred in from 25 to 49% of the grade-courses of study. There is much confusion as to what subject

matter should be taught. However, it is encouraging to find that today over the United States more and more physical science is being taught in the elementary grades, and that the study of animals and plants no longer dominates the science program.

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