Some Problems of Elementary Science*

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In preparing for this discussion today, I was surprised to find that elementary science was discussed by the N. E. A. as far back as 1869; that some Illinois schools have been teaching elementary science for sixteen years. In my ignorance I had supposed that the subject was of more recent origin. However, I believe that it has come into the limelight within the last four or five years. I have been reading School Science and Mathematics since 1908 and until about 1912 there were very few, if any, articles on elementary science. That the interest is becoming keener is evidenced by the appearance of a new journal, "General Science Quarterly", the first number of which has just been issued.

One problem which may confront some schools is to show the need for elementary science. Can you explain to your patrons why another subject has been added to the curricula and why this particular one has been chosen? As science teachers, we would strenuously defend the proposition that at least one science must enter into the scheme of education for every intelligent person. In this we would be backed by Dr. Eliot, who deplores the fact that so many of our professional men lack a scientific education. He points out as an element of weakness in our educational scheme, the fact that so many men otherwise well educated, have never used an instrument of precision. Some subjects will develop mainly the imagination; some the memory, but the sciences stand pre-eminent in developing the powers of observation, in encouraging an inquiring mind, and in training the reasoning powers. Since some science is necessary, the next question is, what science shall it be and when shall it be given?

Our Assistant Commissioner, Mr. Meredith, states that about fifty per cent of all high school students are in the first year, hence, if the majority of our students are to get any science, it must not be later than the freshman year. I presume that we are all of the same opinion on this point. The reports of the U. S. Commissioner of Education show that at the present rate of decrease, science will have disappeared from all schools in the year 1960. The

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decrease in the number of students studying science, as shown in the same report, indicates that something is wrong. If specialized science is losing its grip, let us try general science. Furthermore, physics and chemistry are highly specialized and are, therefore, not adapted to first year students, but elementary science is.

Another problem is what should be the object of a course in elementary science? On this point there is no agreement. Some say that the purpose is to lay a firm foundation for further work in science and to help the student who finds mathematics difficult. Dr. Eliot has said that the most important aim of education is to furnish opportunities for self-discovery. No other subject in the high school can possibly rival elementary science in furnishing opportunities for the student to discover himself. In teaching the elementary facts of astronomy, we may discover a future Herschel, or a brief course in the elements of Geology or Mineralogy may enable a boy to discover that he has an abiding interest in such things; he may become a Dana. A young man of my acquaintance became interested in astronomy through reading one popular article on the subject. The speaker had a ten weeks' course on insects and one of the same duration on birds, and while he did not acquire an extensive knowledge of either subject, he developed an interest in both which has been retained, undiminished. To the criticism that elementary science gives only a smattering of several things we may reply that it is better to have a taste of all the branches of science than a distaste for all. In an elementary science course, one object has been attained when the students are prepared to choose more intelligently their elective subjects of the later years. Another writer states that elementary science should be a course that will introduce the students to the observing of natural phenomena and the recognizing of natural laws in a manner likely to maintain his interest and to stimulate his growth. It should furnish him with information which he is likely to find useful.

In a course outlined in one educational journal, the pupil studies fractional algebraic equations, involution, evolution, surds, exponents, triangles, circles, quadrilaterals, plotting curves, etc. The idea of this course is that elementary science is intended to bolster up the mathematical weaklings. If elementary science is put on this basis, it must inevitably fail. I, for one, do not believe

that elementary science is intended to act as a review of elementary algebra.

Another writer says: "To a deplorably large part of the community the striking of a match, the freezing of water, the falling of snow, the sending of a telegram, the operation of an engine, involve mysteries as profound as the cause of gravitation."

Lewis Ellhuff says that general science has no more relation to future courses in physics and chemistry than it has to future courses in botany, zoology or anything else. Teach the student facts about his own health, the health of the family from which he comes, and the health of the community. A young lady who graduated from high school and college, had studied Latin eight years, Greek seven years, was one of the best mathematicians that ever entered the college, could not tell an oak tree from a pine. At picnics she did not hesitate to eat food over which flies had freely crawled. She was not educated. No one is educated if nature is a closed book to him. Among other things, elementary science should teach common things about the house, such as reading gas meters and putting on ball washers. It should teach the student to read with a greater understanding, much literature which abounds in scientific allusion. He should be able to read more intelligently popular scientific magazines.

If we examine a text-book of trigonometry, we shall find the laws of the sine, cosine and tangent; the formulae for one-half and double the angle, etc., but if we examine an elementary science text, what do we find? What is the author's conception of elementary science? Miss Pease in her book of 1915, devotes 45 pages to the elements of astronomy, 92 pages to the elements of physics; 28 pages to elementary chemistry; 88 pages to physical geography and 52 pages to biology. Barber in his *First Course of General Science* devotes 175 pages to heat and light; 135 pages to meteorology; 32 pages to ventilation; 175 pages to biology, and no attention is paid to chemistry or astronomy. Miss Clark, in her book of 1912, devotes approximately one-half of her book to physics and the other half to chemistry. For her, elementary science means easy chemistry and physics. Hessler gives one-half of his book to physics and chemistry. In a course outlined in *School Science and Mathematics* of November, 1912, elementary science is composed of physics and chemistry.

In the selection of the topics to be studied, why not co-operation

between the teacher and students? Is there any better way to maintain interest at the highest pitch than for the students to assist in selecting the subject matter? John F. Woodhull of Columbia University, says that whatever is worth while in astronomy, botany, chemistry, geology, meteorology, physics, physiology, zoology, etc., may be acquired.

An objection which is often urged against elementary science is that it is duplicated by the biology of the second year, or the physics or chemistry of the third or fourth years. If there is undue duplication the objection is a serious one because Dr. Eliot has said that boys and girls lose one and one-half years in passing through our schools. This loss is due to the study of useless subject matter. If there is to be a further loss of time or efficiency by duplication, the public will rightly point the finger of condemnation at elementary science. A certain amount of duplication might be justified on the ground that it is a review. Many high schools duplicate their mathematics by a review of algebra and geometry in the second semester of the fourth year. However, I believe that the less duplication we have the better our course will be received by the public. Duplication can be easily avoided if the same teacher has all the science as is usually the case in small schools. Or it may be avoided by proper co-operation among the various science teachers or by the superintendent outlining all science courses. Bayonne avoids duplication by giving two years of elementary science based on the biological sciences and devoting the last two years to the specialized physical sciences. In some schools there is little chance of duplication in the case of most commercial students, because, while most of them elect elementary science as freshmen, very few elect the specialized sciences of the third and fourth years.

Another problem confronting some schools is lack of equipment. However, the ingenuity of the teacher should overcome very largely this difficulty because the equipment required for elementary science is not complicated.

Another problem is the dearth of properly trained teachers. Time will, no doubt, solve this problem.

Many teachers, if left free and unrestricted, will teach those divisions of their subject which they like best or in which they are especially well prepared,—hence, another problem is proper supervision so that the over-enthusiastic chemistry or physics devotee

shall not teach formal chemistry or physics when he should be teaching elementary science and making use of chemical and physical subject matter. In other words, it will sometimes be necessary to guard against an over-emphasis of one phase of elementary science at the expense of the others. This can be done either by supervision, an inspection of the teacher's plans, or by a definite course outlined by the superintendent. If this is not done, general science will lose one of its chief claims; i. e., that it is general: it will become special. The writer knows one teacher, an ardent advocate of evolution, who, while teaching general science, carried evolution so far that the clergy of the community said that she was teaching heresy. Surely this was a case for supervision.

In the small high school, the teacher of elementary science is usually the teacher of the other sciences and hence, besides his regular class work he has laboratory work in physics, chemistry or biology, and no time for any laboratory work in elementary science. But any science work to fulfill its highest mission must of necessity contain some laboratory work: the pupil must acquire a working knowledge of laboratory methods. A science course which neglects this, is not science, it is simply a revival of conditions of fifty years ago when science meant the mere study of a text-book. And yet, the speaker knows of elementary science courses which make no provision whatever for laboratory work.

As the writer sees it, general science is an attempt to break down the watertight compartments which have heretofore existed in our science teaching. These watertight compartments do not exist in nature, why should they exist in the school room? The mathematics teachers are coming to the idea of first year mathematics, second year mathematics, etc., instead of algebra, geometry and trigonometry being taught separately.

We may summarize as follows:

There must be a more general agreement as to subject matter.
There must be a more general agreement as to the object which is to be attained.

Avoid undue emphasis on any one topic.

Avoid or minimize duplication.

Make some provision for laboratory work.

Time will solve some of these problems; conferences and the columns of the General Science Quarterly will solve the others.