

The Aims of Science Teaching and Changing Enrollment

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A comparison of the data given in Inglis's "The Rise of the High School in Massachusetts" with those in the 1916 Reports of the United States Commissioner of Education seems to show that there has been a marked decline in the enrollment of science in Massachusetts in the last fifty or sixty years. The figures which Inglis was able to obtain were rather meagre, though they are from such representative towns as North Hampton, Haverhill, Worcester, Newburyport, Lowell, and Springfield. Those for the last two cities are the more complete, and I give in the following table a comparative statement of the number of pupils taking certain subjects in Lowell, Springfield, and Massachusetts, expressed in terms of the percentage of the total high school enrollment. The data for Massachusetts are taken from the last Report of the United States Commissioner of Education.

Subjects	Lowell Av. per cent. 1849-51	Springfield Av. per cent. 1855-61	Massachusetts Av. per cent. 1914-15
Algebra	22.	34.8	33.99
Geometry	5.	27.5	19.71
Latin	37.	41.9	26.69
Greek	2.5	3.6	1.
French	31.	19.5	39.3
Botany	2.5	11.6	5.8
Chemistry	12.5	13.5	8.78
Natural Philosophy	26.5	16.8	Physics 19.71
Physiology	21.5	23.3	5.55
Physical Geography		18.	4.15
Zoology		17.3	1.32
Household Science		15.7	Dom. Economy 6.56
Bookkeeping	35.5	13.9	8.85

The total percent in science in the Springfield high school in the years given, including Household Science is 129.9 per cent.; in

Lowell, 77.5; in Massachusetts 1914-15, 50.18. There are included in the above tabulation some other subjects in addition to science for comparison.

The total science enrollment in the country, expressed in terms of percentage of total enrollment has decreased in the past five years 5.83 per cent. (1916 Report of the U. S. Commissioner of Education, Vol. II, page 489). Chemistry is the only science which shows an increase; Physics has nearly held its own; Physical Geography and Physiology have had a considerable decline; the proportion in Botany has decreased 4.1 per cent.; and in Zoology more than 50 per cent. It is true that Agriculture and Biology have gained in some sections of the country very materially, but these gains do not compensate for the losses in the old-line science subjects. It is also true that there has been a more marked decline in certain other groups of subjects, than in science, such for instance, as in the Classics, 11.04 per cent., and Mathematics, 10.37 per cent. of the total enrollment.

It would seem, to use the words of Snedden "that educators generally who look broadly into the field of secondary education must experience a sense of disappointment as to results now achieved through science teaching."* The figures, apparently, are statistical evidence of such disappointment. Snedden believes that the "fundamental difficulty, here as elsewhere in the field of secondary education, is that we have not yet clearly defined the purpose to be kept in view in our teaching."

Certain it is, that there is no unanimity of opinion as to what science is trying to accomplish either in the grades or in the high school. As a result the course in science lacks coherence; there is no dependent continuity. While much of the science teaching is good in a single subject, it is not coordinated with other sciences of the high school, much less with any work that has preceded in the grades.

As a contribution to the survey of the whole field of science work in the public schools, I submit the accompanying tabulation of purposes. Until we come to some general accepted outline of aims, it is relatively useless to undertake a discussion of methods, for the ends we are trying to reach determine largely the methods we shall use to attain them.

* Snedden, David, *Problems of Secondary Education*, p. 232.

The purpose of science instruction may be tabulated as follows:— The length of the block indicates roughly the proportion of pupils interested in the particular aim; the height, the relative importance of it. The statement of an aim under a definite portion of the school indicates not that it is absolutely confined to such limits but that it is here to be stressed as the most suitable thing for the particular stage of the pupils' development.

The Grades		Junior High School	Senior High School
		The intelligent choice of a vocation and of an avocation, with a knowledge of the fundamental principles of the sciences on which these are based.	
<p>The establishment of (1) a habit of scientific thinking (i. e., thinking to correct proximate conclusions on the basis of observed facts); (2) a habit of carrying the conclusions over into action.</p> <p>The stages in scientific thinking (in the development of the scientific attitude as follows):—</p> <p>A. Rendering concepts exact at essential likenesses: the</p> <p>(a) By a careful accumulation of facts.</p> <p>(b) By devising hypothesis to explain them.</p> <p>(c) Testing these out by experiment to find the true application of an already established law to a particular experience.</p>		<p>The achievement of a conscious ideal, to serve as (1) a means of solving life's problems (2) as a stimulus to independent opinions (3) as a basis of wise action. Realize that as an educational process, scientific thinking is incomplete until the conclusions are incorporated in the life of the pupil.</p> <p>reaction to environment, later they are abstract: the "Why Stage"</p>	
<p>Even before the pupil comes to be problems to shape his actions to meet set up an electric bell, cultivate an order to give practical skills and to stimulate interest in problems that are involved.</p>		<p>sufficiently aware of some of the economic scientific them it is wise to train him to repair the pump, garden, raise fruit, care for chickens, etc., in the moral import of the orderliness of nature and of the pupils obligation to adjust himself to her laws.</p>	
<p>An intellectual and Some appreciation of A grasp</p>		<p>aesthetic appreciation of the commonplace environment, the achievements of science and of the devoted labors of scientists.</p>	
<p>Acquisition of the habit of healthful personal and community living.</p>		<p>and a knowledge of the facts and principles that underlie such habits.</p>	

Knowledge of
Organized
Science

Habitual
Scientific
Attitude of
Mind

Practical
Skills

Appreciation

Health

Until the allied sciences come to some general agreement on the objectives to be reached, there can be no concerted action, no plan of campaign that will assure an advance all along the line in science. I conceive that the science teacher is not teaching science for its own sake, at least not until fairly late in the course of study. To test out results only in the terms of the information acquired, is to ignore the accomplishment of the more important ends. Habits and attitudes of mind, as tools of inquiry in settling the problems of individual living and of a democratic society, appreciation and ideals, are the real things to be achieved in public school science, and the organized knowledge of the sciences and the method of science are means to an end.

Aux Morte

enfants de la patrie, qui, tombé sur le champ d'honneur, ont donné
à la France une gloire sans pareille.

Vive la France! The bugles blew
To summon men from town and field,
'Neath day's warm sun and night's cold dew
To fight and die, but not to yield,
Staking their lives on War's grim chance!
Vive la France!

Vive la France! They marched away
To stop the huge onrushing wave;
On smoking plain, by forest gray,
They saved their land and found—a grave.
No further shall the Hun advance!
Vive la France!

For them no more the cannonade,
The campaign scorched with liquid fire,
The camp, the trench, the wild parade
Of charging hosts through mire and mire.
Sleeping, they dream in Death's cold trance,
Vive la France!

The night breeze wanders o'er the plain
Defiled no more by cruel foe;
The ghostly starlight seeks in vain
The vallant dust that sleeps below;
The winds croon where the moonbeams glance,
Vive la France!

But if once more the foe should come
To scourge the land with fire and gore,
To blast of bugle, roll of drum,
These sleeping dead would rise once more
In spirit, seizing sword and lance,
Vive la France!

Vive la France! Strew fadeless bays,
Sons of brave sires, above their dust,
And sing again their Marsellaise
With larger hope and firmer trust!
Toujours la Liberté avance!
Vive la France!

C. H. STONE