[Journal of the Minnesota Academy of Science](https://digitalcommons.morris.umn.edu/jmas)

Volume 7 | Number 1 Article 20

4-1939

The Pressing Need Of A Practical Non-Technical Course In High School Chemistry

P. M. Glasoe
St. Olaf College

Science Education

THE PRESSING NEED OF A PRACTICAL NON-TECHNICAL COURSE IN HIGH SCHOOL CHEMISTRY

P. M. GLASOE
St. Olaf College

The work of the Committee of Ten of forty-seven years ago was proclaimed by a president of the National Education Association as the most significant contribution to education in our history. While science had been taught here and there, the country was as yet assuming an apologetic attitude toward science. It was by no means universally accepted that science was of the same disciplinary value as Greek, Latin or mathematics. Considering the time, the Committee of Ten took as broadminded a stand toward science as could have been expected. As to the secondary school curriculum they advocated that the sciences of the schools should be taught the same way to all students whether they were preparing "for college, scientific school or neither."

It was evident throughout that the main purpose of the "school" was to prepare for college, that the main object of preparatory schooling was "mind training," and that therefore a fairly rigid course should be required. It was held that the rigid training received in the disciplinary courses, then given, was of equal value to a young person whether he entered college or had to stop his education at the end of the secondary school course.

Rigidity in a preparatory course was a virtue then, and should be now. It was easy to make Greek, Latin and mathematics courses rigid; it was expected that when chemistry and physics were admitted to a place in the curriculum they would have to compare in rigidity with the subjects already there in old standing. A teacher of physics, writing in 1910,[1] complained that, "we have tried to turn physics into mathematics." Mathematics can so easily be made rigid — it was a very natural thing for those who wanted physics to make an impression as a very respectable member of the accredited list of preparatory subjects to make it mathematical. Chemistry has followed the example. It, too, has been made as mathematical as the subject matter allowed. Nothing is easier than to assign a list of problems on the gas laws, temperature changes, calculating of percentages, etc. If they are hard problems the subject is already rigid and chemistry is thereby raised to a position of respectable rigidity.

[1] John W. Woodhull. *Significance of the Requirements in Physics of the College Entrance Examination Board.* School Science and Mathematics, 10:1910, 34.

I have before me a copy of David A. Wells' textbook of chemistry, published in 1858 — hence many years before the Committee of Ten came into being. The book is designed to serve the "needs of students of Academies, Seminaries and Colleges." It differs only slightly from any one of our modern and up-to-date high school texts of 800 pages, or our first-year college texts of 800–1000 pages. Wells' book would scarcely make a volume of 800 pages if it were printed as our new editions are. The book lacks the mathematical rigidity, however, of our modern volumes. It is a small encyclopedia of the chemical knowledge of 1858, which was deemed most useful for the students of that day.

The work of the Committee of Ten would have been wasted but for the cooperation of schools and colleges in putting its far reaching conclusions into practice. So we find the cooperation expressing itself in the forming of the College Entrance Examination Board and later in the entrance examination requirements of the regents of the State of New York. Naturally, what these organizations decreed became standards for the country. Carefully prepared syllabi followed. These standards in examinations not only tested the knowledge and training gained by the students, but set up rigid requirements for the schools and academies, whose very lives depended on having their students pass the examination given.

The influence of the College Entrance Examination Board has been spoken of as a "domination." It has wielded a sort of tyranny over the schools. Protests have frequently been made against this. Woodhull [2] voices such a grievance when he inveighs against "memoriter work," lack of rationality in subject matter and subsequent examinations, when he says: "We have preached against mere memoriter work until our preaching has taken some effect in high school teaching, but we continue to give examinations which no amount of general intelligence would enable one to pass. . . . I undertake to say that the more rational our instruction becomes the less will our pupils be able to pass the examinations as now given." He advocates that a commission be created to appeal to the College Entrance Examination Board. . . . "Nobody will question the profoundness of their influence (the College Entrance Examination Board) in establishing the content of textbooks and syllabi." [3]

If it can be said that the standards of rigidity adopted in 1892 — good for boys and girls whether they were seeking to fulfill entrance requirements "to college, scientific school or neither" — are still holding the subjects under their guidance and control, whatever the higher-up authority may be, certainly those subjects must be said to have become "static." Comparing Wells' with the standard texts of today I find that the only difference is that the latter are modernized: that is, they contain all the new essentials discovered since

[2] Woodhull: *loc. cit.*

[3] Francis D. Curtis. Year Book, No. 31, National Society for the Study of Education, Page 115.

1892, in addition to all the old. The new books are chemical encyclopedias up to date.

Samuel T. Dutton, superintendent of schools at Brookline, Massachusetts,[4] says: "As I review the history of the past fifty years I can think of no activity that has been so slow in adapting itself to new conditions as has teaching. . . . Education in this country has clung too closely to old ideas and conditions and has not adapted itself easily to new situations. It has been too abstract and general and has not recognized the place vocation holds in the life of the individual and the nation."

The objection was raised, as stated by Inglis,[5] that the Committee of Ten "failed to arrange the work so as to meet the needs of pupils who leave school before the close of the course; its recommendations tended to organize the study of the sciences in terms of the subjects rather than in terms of the capacities of the pupils and their later needs; it failed to recognize the need of relating the study of the natural sciences more directly to life with reference to the vocations.

We are up against this peculiar situation: the chemistry and physics courses offered in standard texts of today are fairly identical with the books of fifty to sixty years ago; they were small compendiums then, they are encyclopedias now. These books are accused of being written to carry out the "suggestions" of the examining authorities. Some years ago I read that the big flour millers pleaded that they were forced to bleach their flour—the housewives drove them to it. Our textbooks are "static" because the college entrance authorities have outlined the requirements and have stuck to them.

All the time that these courses have been kept in the old grooves there have been efforts made to bring the science courses "back to the people." Says Smallwood,[6] as early as 1910: "The tendency in secondary school scientific education is away from the technical exactness of university methods towards a more generalized and humanized survey; in closer touch with everyday activities of the commercial and business world; . . . in the direction of a more limited content, greater simplicity of presentation and closer articulation with the life-experiences of the pupil."

Ten years later comes Edwin G. Pierce,[7] who says: "If college requirements have warped our secondary education into something that is unreal and of little value in itself, then college requirements, or our control by them, should be changed."

It seems that something is wrong. George R. Twiss[8] calls attention to the following statistics: "Of every 100 children who enter

[4] Samuel T. Dutton, Educational Review, Vol. 12, Page 338.
[5] Alexander Inglis, *Principles of Secondary Education*, Page 509.
[6] Wm. Smallwood. *School Science and Mathematics*, Vol. 10 (1910), p. 304.
[7] Edwin G. Pierce. *A High School Course in Trade Chemistry*. School Science and Mathematics, Vol. 20, (1920), Page 27.
[8] Geo. R. Twiss. *School Science and Mathematics*, 20; 1, (1920).

our public schools approximately 50 remain to enter the eighth grade, 35 enter high school, 20 get into the second year, only 10 graduate, and of these only 5 enter college." If we then consider that of these five one elects college chemistry we get a fairly accurate picture of where we stand. If we can rely on the advertising literature sent us by the big publishers we conclude that the age-old requirements of the College Entrance Examination Board as reflected in even the most recent issues of the high school texts are still standard in hundreds of American high schools. They are rigid, of course; it is a very easy matter to make a high school textbook of 800 pages rigid. A task master, with more justice than mercy in his make-up, can set before his classes the task of memorizing those thousands of facts, unrelated and unsystematized as they are, and then turn the candidates over, "pressed down and running over," to the College Entrance Examination Board for the final rites in connection with the secondary school program. Woodhull counts it a commendation of the high schools when the secretary of the College Entrance Examination Board had to say that "a larger number of candidates than usual failed to pass the examinations." This is, no doubt, a measure of the internal revolt going on against the standardized rigidity of the examinations.

If it is of importance for us to educate the masses — we are certainly failing as far as chemistry is concerned. Our high school courses are still administered on the basis of the principle that what is good for the young people who are going to enter college is good for those who do not. But what does the college entrance requirement mean to our high school youth? They are put through the highly artificial and technical course, outlined by the examining authorities, only to be submitted to a repetition course in first-year college which is a high school chemistry course slightly matured. The high school course does not prepare them for college, it prepares for admission to college. Like as not, when they get to college, they are put into the same lecture course and set to doing the same laboratory exercises as those required of students who have not had the preliminary course. The thanks which the student, his teacher and his school get from the higher-ups is expressed in the dictum that he would have been better off had he come without the high school credit; or, the still more withering condemnation, that at the end of two quarters no one could tell him from one who has not had the high school course in chemistry. And that, by the way, is the nastiest slander which can be spoken against a group of college freshmen. A college, where such a discovery is made, should seriously investigate its own methods of instruction. A dead woodchuck will be found in their own wood-pile.

But the tragedy of the whole miserable situation lies in the fact that by the administration we give our high school chemistry course we are keeping thousands of boys and girls out of it. They have learned to know the chemistry course as "stiff," rigid, mathematical and, over all, uninteresting. We hope that the course as given is "mind training," disciplinary, cultural — but what is the use when we reach only about two out of every hundred of our children with it? Just think of the ninety-eight who have to go through life knowing little or nothing about the wonders of nature and life which need a chemical explanation.

What we need is a new high school course. We need to cut ourselves completely off from the static outline of 1892. Let us not be fooled by this college entrance slogan; it doesn't prepare for college anyway; let us get away from the heresy that to be a good course it must be mathematical and technical — if you and I are any good as teachers we can make chemistry both practical, cultural and above all, so interesting that the young people will take it and like it.

Otis W. Caldwell wrote last year,[9] "Until recent times, relatively, this growing knowledge dealt almost wholly with ways in which men might make better use of nature. . . . A few scientific men began to see the elements of a *philosophy of living* as a derivative of science. Do all citizens come into possession of the knowledge amassed by science? They do not, and therein lies a great danger. Education, including scientific education of all the people is needed . . . a thoughtful consideration of the possibilities of good or harmful uses of the unprecedented power made possible by modern science forces the conclusion that better scientific education is needed by the largest possible number of those whose welfare is to be largely determined by modern science." It does very little good to argue in favor of scientific education of the masses, when we know that the average high school student graduates with credit in one single year-course of science.[10] When we remember that only about ten per cent of American children graduate from high school our emphasis on high school science becomes meaningless prattle. If, in this age of air-ships, radio, radium, and colored moving pictures, we can induce only a few to study chemistry it amounts to a declaration of failure. Something fundamental must be very wrong.

There is no argument about the fact that science leads children on the road to rich living.[11] The trick is to get them on the road. How far we are from such a goal is indicated by the statement that the average high school graduate of today has all but escaped contact with science. And that in the *midst of a scientific age!*

That there is a real need felt by many and that an effort is sporadically being made to meet it is shown by the number of reports you find of "Chemistry Course for Girls," "Chemistry for Household Science Classes," "Practical Course for Girls," "Elementary Technology for High School Students," etc. In spite of all these attempts, some of them very successful, we find ourselves re-

[9] Otis W. Caldwell. Year Book, 36, *National Society for the Study of Education,* Part II, Page 185.

[10] E. L. Palmer, *National Society for the Study of Education,* General Comments on Year Book, 31, Page 364.

[11] S. R. Powers, Year Book, 31, *Nat. Society for Study of Education,* Page 59.

verting to the standards set by the Committee of Ten or some examining authority. It means that we are still training all our high school youth to enter college on the basis that what is good for John, who goes to college, is good for Jane who doesn't. What we need is a course in chemistry — call it about chemistry, if you prefer — that shall introduce enough subject matter to acquaint the pupils with the nature of chemistry, its conception of element, compound, atom, molecule, definite composition, etc., as they are needed. There is no need of spending six or even three months "laying the foundation." Start with what they know — they know at least ten metals, and a few less non-metals. They know about sour substances and common basic compounds — this leads to the universal generalization of neutralization; they know about oxygen and oxidation, and you teach them about reduction. As you go along you introduce chemical explanations *when they become necessary.*

As soon as they have the idea of atom they will easily grasp the idea of atomic weight. If you, then, take the seven elements of the sodium-to-chlorine series of the Periodic System — all of which they know by name, at least, and show how they follow each other in definite order of weight, you have all you need for teaching metal and nonmetal, basic and acidic, positive and negative, chemical affinity, combination, degree of affinity, and stability of compounds. You do not have to introduce a single irrelevant fact or phenomenon — just because they are chemical — introduce them as you need them, as you are going to need them.

Right here, there has been a great deal of groping and fumbling with the best of intentions. Many have suggested that chemistry should be brought close to the pupil. He should be taught the meaning of chemistry to life. Practically every phase of applied chemistry has been suggested. But here, attention has been called to the fact that girls and boys are not interested in the same things, so what can be done in the average school where sectioning is impossible?

Here is a suggestion. Every student has to live, (you can get no closer to them than to speak of their own life and living). In order to live their lives from day to day they must have *shelter, clothing and food.* Why go afield to find machines for the boys or problems of a domestic nature for girls? Every human body is a machine — and what a machine, so fearfully and wonderfully made! Do you want to study about oxygen? The breathing problems of every boy and girl present themselves. What does breathing mean? By what law does oxygen enter the blood from the lungs and carbon dioxide come out? What becomes of the oxygen that enters the blood? Where does the carbon dioxide come from? How is all this related to the temperature of the body? Where does all the energy come from? Our food as body fuel furnishes the answer. You have just begun the subject from the standpoint of bodily needs.

Would you study water? The fact that water is made up of hydrogen and oxygen is important and interesting; as a fact it is soon forgotten, but think of how the subject is enhanced when you show how people and plants exhale water, how water makes up the bulk of blood, milk, watermelon and our bodies; how water is leveling off the country-side by washing the top soil into our rivers and thence down to the deltas sticking out into the ocean; how water carries diseases, mineral matter and useful substances required for health; how homes and cities pay out big sums for softening their water supplies; how waters in different localities differ in composition; requiring different treatment, etc., etc. You have just touched the water problem.

Then the problem of shelter. Building materials are all chemical compounds; the preparation of mortar, lime, cement, putty, paint; the different woods, steels, glass, brass, zinc, porcelain, enamels; the difference between marble, sandstone, dolomite, granite, brick and tile.

And what about clothing? The problem deals generally with the subject of textiles. Here are the different fibres: wool, cotton, silk, rayon, linen, ramie or bast, hemp, jute, raffia. How are they produced? Prepared for use? How are they used? Silk for instance: How produced? How is silk inferior to rayon? In what superior? The first attempt to make artificial silk was carried out by trying to convert mulberry leaves into fibre without having them go through the silk worm. Now, 2000 pounds of pine wood is converted into 1500 pounds of fine rayon.

Finally, our foods. The three main classes of carbohydrates, fats and proteins; each so easily illustrated, so important and full of significance in daily life. But, this is way over the heads of the high school boy or girl, isn't it? Yes, it is. Most of it is over your head and mine. If we wait until we understand we shall never get started. We don't understand chemical affinity; we don't understand why cells make starch, sugar, fat — we know such things happen, but why, that is a mystery. So we might as well talk to boys and girls about the things that concern them even though we have to confess that we do not understand. In fact to say that we understand chapter 20 because of the foundation laid in chapters 1–19 is simply a delusion — we understand none of it.

Much is said about unification of science. Such a course as this requires the constant reference to physics and its facts and methods; biology is ever in the background; geology; meteorology, yes, even astronomy can come in for a share of attention. Sociology is constantly receiving attention.

Finally, in this kind of a course you have brought science near to the pupil; you have made him see the relations of scientific fact to daily living; you have made him conscious of the fact that science is not for school room and laboratory, but for the teeming experiences of home, field, stream, factory and store. Some teachers have succeeded in making physics a living reality by starting with the automobile; introducing the principles of mechanics, heat, light and electricity, most realistically. Any person who hires out to teach chemistry should be able to take the human automobile and make every lesson as real as living itself.

One thing is very certain — this course will not lead to a repetition in first-year college; it makes a noble attempt to give something to the young people which will be of value to them whether they "prepare for college, for scientific school or neither."

AN OPPORTUNISTIC PHYSICS LABORATORY —ABSTRACT—

G. M. WISSINK
Mankato State Teachers College

During the regular first year college Physics course many demonstrations were performed to give the student a better understanding of the physical principles involved in different natural phenomena. In the laboratory students themselves performed certain fundamental experiments so that they might develop certain manipulative skills as well as understandings which are necessary for successful teachers of science.

Several of the students enrolled in Physics courses became interested in trying different experiments not performed during the regular laboratory course. The experiments that students wanted to try were usually modifications of the fundamental laboratory work and often they were quite original. Whenever a logical and feasible explanation or description of the method of procedure was presented, the student was encouraged to undertake the work. The Physics laboratory was therefore kept accessible so these students might have an opportunity to work out experiments and problems of their own.

Naturally, this type of work took much of the student's time as well as the instructor's, and so it was deemed advisable to offer a course in "Experimental Physics" in which the students could do their work for college credit.

Only students vitally interested in laboratory work enrolled. Projects on which the students wished to work were limited to the scope of the laboratory and only projects which could be carried on in the limited time were permitted. In every case, projects were chosen which would contribute to the training of prospective teachers. The building and construction of simple demonstration equipment as well as the adaptation of special equipment to various purposes received a great deal of attention.

The projects undertaken by the students varied greatly. Some students were mainly interested in electricity, others in mechanics,