5. The Relation of Pure and Applied Science in Secondary Education.

Worrallo Whitney.

The field which the subject of this symposium covers is so great that, for the limited time at my disposal, it seems best to confine my inquiry to some one phase of the question. I have chosen, therefore, a topic that has interested me for some time, one which is finding expression among science teachers in the agitation for a general science course for the first year of the high school course of study. I shall inquire into the position of science in the curricula of the high schools, especially as to whether science is receiving the attention it deserves in comparison with its importance in every day life and in comparison with other departments in the high school. The question also as to whether the applied sciences now being added to the curricula of many schools are being articulated with the pure science courses already in the course of study is an important one.

It does not seem very necessary to call attention to the increasing importance of science in every day life. Every one is familiar with the facts of the achievements of science, especially those that are spectacular, but these achievements are becoming such an every day matter, taken for granted that one must pause to think, before he realizes fully how far-reaching the field of science really is, and how fast it is increasing these days, with the advances in electricity, transportation, gas, sanitary and medical science, agriculture, forestry, etc. Take the one field of sanitary science; the advance from simple guess work to accurate scientific knowledge has meant the saving of untold thousands of lives, and its work for good has just begun. Its field is in every home, of more importance in the homes of the ignorant and poor than in the homes of the educated and rich.

Few can doubt that agriculture will, in the near future, be rescued from the ruts into which it has fallen on account of the virgin fertility of the soil and put upon a scientific basis. Many are beginning to recognize that the hope of a prosperous future of our country depends upon this.

In view of the supreme importance of science in life, one would expect to find it occupying a commanding position in the curriculum of every secondary school. But educators are conservative. Tradition and custom are binding forces that tend to hinder rational response to changed conditions. A glance at the history of educational methods shows this tendency toward conservatism to be very strong.

In mediaeval times education was solely for those who did not work with their hands. The classics furnished the basis for educational training, for indeed there was little else, and it answered the purpose. In time, human freedom gradually broadened and with it education reached down from the idler and scholar to the workers. As education became more widespread and free schools established, the number fitting for college greatly increased. Finally, little more than a half century ago the first public high schools were established. But instead of these schools growing up out of the elementary schools, they were patterned after the colleges.

The colleges had been the bulwark of conservatism, and till a few years ago, comparatively, the classics still held their place in the front rank of what was deemed best for educational training, almost a fetich to the educators of the colleges. The men who were called to make the curricula of the high schools came from the colleges, and we need not be surprised when we find the languages still occupying the front rank in the high schools, even more than in the colleges themselves.

Let us now inquire into the actual conditions we may find in the curricula of the high schools. I will first analyze the course of study of the Chicago high schools, since I am more familiar with these schools. Some explanation of terms is necessary for a clear understanding of the figures. High schools usually give one credit toward graduation for five recitations per week in one subject for a year, two laboratory periods counting as one recitation period. Manual training, music, drawing, and domestic science usually required two periods of work as an equivalent to a recitation period. The unit course then is five recitations per week in one subject for one year. But as a few schools, including those of Chicago, have many courses with only four or even fewer recitations per week, giving however corresponding credit, it will be more convenient in this paper to use hours (periods) in place of unit courses, understanding that five hours constitute a unit course.

Chicago offers a total of 211 hours work, about forty-two courses, in her high schools, not including manual training which is localized in a few schools, and omitting domestic science and art which are not fully organized. By departments the courses are distributed as follows:

Foreign language........91 hours, or about 45% of the total number of hours offered.

English	16	hours,	or	about	8%
History	20	"	"	"	10%
Commerce (including arithmetic).....	26	"	"	"	13%
Mathematics	14	"	"	"	7%
Science	24	"	"	"	12%
Music, drawing, etc.	20	"	"	"	10%

The cultural subjects, language and history, constitute 63% of the total courses offered against 37% in all other subjects. It will be noticed, also, that the commercial department, one of the most recently established, offers a greater number of hours than science, twenty-six hours of commercial work to twenty-four hours of science, and this is counting physiology, geology and astronomy as sciences though they are not usually given with laboratory courses in the Chicago schools, and should really not be counted as science. Excluding these subjects, Chicago offers only nineteen hours work in the laboratory sciences. Excluding from the foreign language group Greek and Spanish, which are not given in most of the schools, Chicago offers 57 hours in foreign language to 19 hours in science, exactly three to one.

In order to compare this with other schools of the state I sent out fifty requests for courses of study, twenty-five to township high schools and twenty-five to city and village high schools and received forty replies. With these forty courses of study I constructed a table showing the number of hours offered in each department and showing also the distribution of the science courses offered by each school.

Studying this table I find that the ratios remain about the same as in Chicago except that there are fewer courses in the foreign languages and often more in the sciences (not including domestic science). The courses offered in the foreign languages in the various schools range from 20 hours to 95 hours in amount. While the courses offered in science range from 15 hours to 35 hours, averaging 41 hours of foreign language to 23 hours of science. No distinction is here made between laboratory science and text-book science, since many of the courses of study did not indicate the methods used in the school. Physiology is required and is usually given without an accompanying laboratory course. I estimate that 20 hours is about the correct average of the laboratory sciences, or about 13% of the average total number of hours offered.

Of equal importance with the amount of time given, and growing directly out of this, is the organization of the courses. In Latin, for example, we find a well organized four year course, each succeeding year building on the work of the preceding year, the whole forming a graded series with one object in view. The same is true of the other foreign languages and of English as now taught in the schools. In history the courses are consecutive, beginning with ancient history and ending in most schools with American history and civics. In even the latest subjects to be added to the curriculum as in the case of the commercial department, most schools offer a graded series of four to six unit courses preparing for business life.

Now, how is it with science? We find four years work usually offered, consisting of physical geography and physiology in the first year, botany and zoology or a year of either in the second, and physics and chemistry or chemistry and physics in the third and fourth years. This is not, in any sense, a graded course as in Latin, German and other subjects. It is rather a series of fragments of science, with a half year or a whole year devoted to each fragment. The series cannot be called a four year course comparable with the courses in other

City and Village High Schools.	Total No. periods offered in all departments.	Total periods ("hrs.") offered in each department.									First Year.	Semesters.	Periods	
		Foreign language.	English.	History.	Mathematics.	Commercial.	Science (pure.)	Dom. Science.	Man. Training.	Agriculture.				
Alton	** 125	40	20	15	15	10	25	....	....	..	Phys. Geog. ... Physiology	1 1	4 4	
Aurora	160	35	20	20	20	20	20	10	10	..	Phys. Geog. .... Dom. Science ..	2 ...	7 ..	
Canton	132½	30	20	20	15	20	27½	....	....	..	Phys. Geog. .... Physiology	2 1	.. ..	
Champaign ...	150	35	20	15	15	35	20	....	10	..	Physiography .. Phys. Geog.	1 1	5 7	B Pl Pl
Charleston ...	112½	20	20	12½	15	7½	20	7½	10	..	Phys. Geog. .... Botany .... Dom. Science ..	1 1 2	 2	Zo Phy Do
Clinton	133	30	20	15	17½	20	22½	8	....	..	Physiology ..... Botany .... Dom. Science ..	2 1 2	5 7 4	Phy Zoo Dom
Belleville	.....	..	..	....	....	....	22½	....	....	..	Physiology ..... Phys. Geog.	2 1	5 5	Bota
Elgin	172½	35	20	15	17	20	27½	5	10	..	Physiology ..... Phys. Geog. ... Dom. Science ..	1 2 2	5 5 7	Botar Zoolo
Galesburg	123	25	20	15	15	25	15	3	5	..	Zoology .... Botany .... Physiology	1 1 1	.. .. ..	Physic Dom.
Mattoon	107½	30	20	17½	15	5	20	....	....	..	Physiology .... Phys. Geog. ...	1 1	5 5	Zoology Botany
Danville	170	45	20	25	15	35	25	5	....	..	Phys. Geog. .... Dom. Science ..	2 2	5 5	Botany
Moline	175	40	20	15	17½	30	25	6	25	..	Botany .... Physiology .. .. Dom. Science ..	2 1 2	7 3 4	Zoology Phys. G Dom. Sc
Freeport	187½	35	20	10	17½	35	20	20	20	10	Bot. or Zool. .. Dom. Science .. Agriculture	2 2 2	.. .. ..	Zool. or Dom. Sci Agricultu
Decatur	137½	45	20	20	20	10	22½	....	....	..	Phys. Geog. .... Physiology	1 1	5 5	Zoology .. Botany ..
Pekin	140	40	20	15	15	30	17½	....	....	..	Phys. Geog.	1	..	Biology ..
Rockford	175	45	20	15	17½	30	27½	....	15	..	Phys. Geog. & .. Physiology ...	... 2	.. 5	Botany .. El. Chem. Dom. Scien
Springfield ...	200	55	20	20	20	20	25	20	20	..	Physiology ..... Phys. Geog.	1 1	5 5	Zoology .. Botany ...
Watseka	120	20	20	10	10	20	20	5	5	..	Phys. Geog. .... Botany	1 1	6 7	Zoology .. Physiology .
Peoria	185	65	20	15	20	35	20	....	10	..	Phys. Geog. ...	1	..	Zoology .... Botany .. ..
Kewanee	137½	35	20	15	17½	30	20	7½	....	..	Physiology ..... Phys. Geog.	1 1	.. 5	Zoology ..... Dom. Science
Paris	100	30	20	10	15	5	20	....	....	..	Phys. Geog. ... Physiology	1 1	5 5	Botany ..... Zoology .....
Chicago	191	91	16	20	14	26	24	?	....	..	Physiology ..... Phys. Geog. ...	½ 1½	4 6	Botany & Zool. or Botany ...... Zoology ......

Note: The utmost care has been taken in compiling this table to insure accuracy, but the author is conscious that omitted from the courses of study, or was given in such a manner that it was not easy for a stranger to interpret it

* For the sake of comparison double laboratory periods and all work on laboratory basis are reduced to equivale for one year constitute a course as usually given.

** The amounts given in this column do not include the special studies such as drawing, music, rhetoricals, etc., for

City and Village High Schools.	Total No. periods offered in all departments.**	Total periods ("hrs.") offered in each department. Foreign language.	English.	History.	Mathematics.	Commercial.	Science (pure.)	Dom. Science.	Man. Training.	Agriculture.	COURSES IN SCIENCE BY YEARS. First Year.	Semesters.	Periods per w'k.	Second Year.	Semesters.	Periods per w'k.	Third Year.	Semesters.	Periods per w'k.	Fourth Year.	Semesters.	Periods per w'k.
Alton	125	40	20	15	15	10	25	....	....	..	Phys. Geog. Physiology	1 1	4 4	Botany Zoology	1 1	4 4	Physics	2	7	Chemistry Geology Astronomy	2 1 1	7 4 4
Aurora	160	35	20	20	20	20	20	10	10	..	Phys. Geog. Dom. Science	2 ...	7 ..	Botany Zoology Dom. Science	1 1 ..	7 7 ..	Chemistry	2	7	Physics	2	7
Canton	132½	30	20	20	15	20	27½	....	....	..	Phys. Geog. Physiology	2 1	.. ..	Botany Zoology	1 1	.. ..	Physics Geology Astronomy	2 1 1	.. .. ..	Chemistry	2	..
Champaign	150	35	20	15	15	35	20	....	10	..	Physiography Phys. Geog.	1 1	5 7	Biology Physiology, or Physiology	1 1 1	7 7 5	Physics	2	7	Chemistry	2	7
Charleston	112½	20	20	12½	15	7½	20	7½	10	..	Phys. Geog. Botany Dom. Science	1 1 2	 2	Zoology Physiology Dom. Science	1 1 2	 2	Chemistry	2	..	Physics Dom. Science	2 2	.. 2
Clinton	133	30	20	15	17½	20	22½	8	....	..	Physiology Botany Dom. Science	2 1 2	5 7 4	Phys. Geog. Zoology Dom. Science	1 1 2	5 7 4	Chemistry Dom. Science	2 2	7 4	Physics Dom. Science	2 2	7 4
Belleville	.....	..	..	....	....	....	22½	....	....	..	Physiology Phys. Geog.	2 1	5 5	Botany	2	5	Chemistry	2	7	Physics	2	7
Elgin	172½	35	20	15	17	20	27½	5	10	..	Physiology Phys. Geog. Dom. Science	1 2 2	5 5 7	Botany Zoology	2 2	7 7	Chemistry	2	8	Physics	2	8
Galesburg	123	25	20	15	15	25	15	3	5	..	Zoology Botany Physiology	1 1 1	.. .. ..	Physics Dom. Science	2 2	.. ..	Chemistry Dom. Science	2 2	.. ..	•		
Mattoon	107½	30	20	17½	15	5	20	....	....	..	Physiology Phys. Geog.	1 1	5 5	Zoology Botany	1 1	7 7	Chemistry	2	7	Physics	2	7
Danville	170	45	20	25	15	35	25	5	....	..	Phys. Geog. Dom. Science	2 2	5 5	Botany	2	5	Physics Zoology	2 2	8 5	Chemistry	2	8
Moline	175	40	20	15	17½	30	25	6	25	..	Botany Physiology Dom. Science	2 1 2	7 3 4	Zoology Phys. Geog. Dom. Science	2 1 2	7 5 4	Chemistry	2	7	Physics	2	7
Freeport	187½	35	20	10	17½	35	20	20	20	10	Bot. or Zool. Dom. Science Agriculture	2 2 2	.. .. ..	Zool. or Bot. Dom. Science Agriculture	2 2 2	.. .. ..	Physics Dom. Science	2 2	.. ..	Chemistry Dom. Science	2 2	.. ..
Decatur	137½	45	20	20	20	10	22½	....	....	..	Phys. Geog. Physiology	1 1	5 5	Zoology Botany	1 1	7 7	Chemistry	2	7	Physics Astronomy	2 1	7 5
Pekin	140	40	20	15	15	30	17½	....	....	..	Phys. Geog.	1	..	Biology	2	..	Physics	2	..	Chemistry	2	..
Rockford	175	45	20	15	17½	30	27½	....	15	..	Phys. Geog. & Physiology	... 2	.. 5	Botany El. Chem. & Dom. Science	2 2	7 3	Zoology Physics Dom. Science	2 2 2	7 7 3	Chemistry Astronomy	2 1	7 5
Springfield	200	55	20	20	20	20	25	20	20	..	Physiology Phys. Geog.	1 1	5 5	Zoology Botany	1 1	10 10	Physics	2	7	Geol. & Astron. Chemistry	2 2	5 7
Watseka	120	20	20	10	10	20	20	5	5	..	Phys. Geog. Botany	1 1	6 7	Zoology Physiology	1 1	8 6	Physics	2	7	Chemistry	2	7
Peoria	185	65	20	15	20	35	20	....	10	..	Phys. Geog.	1	..	Zoology Botany	1 1	7 7	Physics	2	7	Chemistry	2	7
Kewanee	137½	35	20	15	17½	30	20	7½	....	..	Physiology Phys. Geog.	1 1	.. 5	Zoology Dom. Science	2 ..	.. ..	Chemistry	2	..	Physics Dom. Science	2 2	.. ..
Paris	100	30	20	10	15	5	20	....	....	..	Phys. Geog. Physiology	1 1	5 5	Botany Zoology	1 1	7 7	Chemistry	2	..	Physics	2	7
Chicago	191	91	16	20	14	26	24	?	....	..	Physiology Phys. Geog.	½ 1½	4 6	Botany & Zool. or Botany Zoology	2 2 2	6 6 6	Physics	2	6	Chemistry Geology Astronomy	2 1 1	6 4 4

Note: The utmost care has been taken in compiling this table to insure accuracy, but the author is conscious that there may be some errors. Often the information sought was either omitted from the courses of study, or was given in such a manner that it was not easy for a stranger to interpret it or gather just the information needed.

* For the sake of comparison double laboratory periods and all work on laboratory basis are reduced to equivalent recitation periods. Five recitation periods ("hours") per week for one year constitute a course as usually given.

** The amounts given in this column do not include the special studies such as drawing, music, rhetoricals, etc., for which many schools give credits.

COMPARATIVE TABLE OF HIGH SCHOOLS, SHOWING:

(1) The total number of hours* (periods)* work offered in all departments and in each department;
(2) The courses in science by years.

Township High Schools.	Total No. periods ("hrs.") offered in all departments.	Total periods ("hrs.") offered in each department.									COURSES IN SCIENCE BY YEARS.											
		Foreign language.	English.	History.	Mathematics.	Commercial.	Science (pure.)	Dom. Science.	Man. Training.	Agriculture.	First Year.	Semesters.	Periods per w'k.	Second Year.	Semesters.	Periods per w'k.	Third Year.	Semesters.	Periods per w'k.	Fourth Year.	Semesters.	Periods per w'k.
Savanna	* 117	* 30	16	15	12½	21½	20	..	2	....	Physiology Phys. Geog.	1 1	7 6	Zoology Botany	1 1	7 7	Chemistry	2	7	Physics	2	7
Pontiac	127½	30	20	20	17½	20	20	..	....	....	Phys. Geog. Physiology	1 1	5 5	Zoology Botany	1 1	7 7	Physics	2	5	Chemistry	2	5
Streator	180	45	20	20	20	30	20	15	10	....	Phys. Geog. Dom. Science	1 2	5 5	Botany Zoology Dom. Science	1 1 2	7 7 5	Physics Physiology Dom. Science	2 2 2	7 1 5	Chemistry	2	7
New Trier	237	75	20	20	20	40	25	12	20	....	Phys. Geog. Dom. Science	2 2	7 5	Botany Dom. Science Zoology	2 2 2	7 5 7	Chemistry Dom. Science	2 2	7 5	Physics Dom. Science	2 2	7 5
Sterling	135	45	20	15	17½	5	32½	..	....	....	Biology Phys. Geog. Physiology	2 1 1	10 5 5	Botany Zoology	2 2	10 10	Physics	2	7	Chemistry Astronomy	2 1	8 5
Geneseo	124	30	20	15	15	15	21	4	4	....	Phys. Geog.	2	..	Zoology Physiology Dom. Science	1 1 ..	.. .. ..	Botany Physics Dom. Science	2 2 ..	.. .. ..	Chemistry	2	..
Evanston	155	65	15	20	20	....	25	..	10	....	Phys. Geog. Physioloy	1 ½	5 5	Botany Zoology	2 2	7½ 7½				Physics, or Chemistry	2 2	7 7
Waukegan	195	50	20	15	15	35	25	10	10	....	Phys. Geog. Dom. Science	2 2	7 10	Zoology Botany Dom. Science	2 2 2	8 8 10	Physics	2	7	Chemistry	2	7
Centralia	165½	30	20	20	15	35	22½	20	....	....	Phys. Geog. & Gen. Science Dom. Science	2 2	.. ..	Dom. Science Zoology Botany Physiology	2 1 1 1	.. ..	Physics Dom. Science	2 2	.. ..	Chemistry Dom. Science	2 2	.. ..
La Salle	240	65	20	15	17½	30	32½	20	20	20	Gen. Science Phys. Geog. Physiology Dom. Science	1 1 1 2	10 10 5 10	Biology Botany Zoology Dom. Science	2 2 2 2	10 10 10 10	Physics Dom. Science	2 ..	10 ..	Chemistry Chemistry Agriculture 4 yr. course.	2 2 ..	10 10 ..
La Grange	150	45	20	15	17½	10	22½	..	20	....	Botany	2	5	Zoology	2	5	Chemistry Phys. Geog.	2 1	5 5	Physics	2	5
Murphysboro	124	40	20	20	15	....	20	6	3	....	Physiology Phys. Geog. Dom. Science	1 1 2	7 7 3	Zoology Botany Dom. Science	1 1 2	7 7 3	Chemistry	2	7	Physics	2	7
Joliet	245	95	30	30	25	20	42½	..	....	2½	Phys. Geog.	2	..	Botany	2	..	Physics Adv. Botany Zool. & Physiology Agronomy	2 1 2 1	.. ..	Adv. Physics Chemistry Chemistry Inorg. Geol. & Astron.	2 2 2 2	.. ..
Marshall	115	35	20	15	15	10	20	..	....	....	Physiology Phys. Geog.	1 1	5 5	Biology	2	7	Chemistry	2	7	Physics	2	7
Gibson	100	25	20	15	15	10	15	..	....	....	Physiology	2	5				Zoology Botany	1 1	.. ..	Physics	2	..
De Kalb	142½	35	20	20	17½	20	20	5	....	5	Agriculture Zoology Physiology Dom. Science	1 1 1 2	 3	Agriculture Botany Phys. Geog. Dom. Science	1 1 1 ..	.. ..	Physics	2	..	Chemistry	2	..
Oak Park	182½	65	20	20	20	15	25	..	17½	....	Gen. Science	1	7	Phys. Geog.	1	7	Botany Zoology Physics	2 2 2	7 7 7	Chemistry	2	7
Princeton	160	40	20	15	15	30	30	5	....	5	Phys. Geog. Physiology	1 1	5 5	Zool. & Bot. Botany Agriculture	2 2 2	7 7 7	Physics Dom. Science	2 2	7 8	Chemistry	2	7
Ottawa	187½	70	20	10	15	25	27½	10	10	....	Gen. Science	2	3	Botany Zoology	2 2	.. ..	Phys. Geog. Chemistry Dom. Science	2 2 2	5 7 ..	Physics Dom. Science	2 2	7 ..
Clyde	.....	..	..	....	....	....	20	..	....	....	Phys. Geog.	2	5	Zoology	2	6	Physics	2	8	Chemistry	2	8
Lockport	200	30	20	12½	27½	30	35	20	20	5	Botany Phys. Geog. Physiology Dom. Science	2 1 1 2	7 6 5 4	Geology Zoology Dom. Science	1 1 2	5 7 4	Agriculture Chemistry Dom. Science	2 2 2	7 7 4	Physics Surveying Astronomy Dom. Science	2 1 1 2	7 7 7 4

departments. The principal value of Latin as an educational factor in high schools has been due not so much to any intrinsic merit in the study *per se,* as to the carefully graded work on one single subject for four years, thus giving time and opportunity for cumulative development and disciplinary training of the mental activities of the pupil. What would be thought of any school that offered four or more one-year courses in as many languages as a substitute for the usual well graded courses now offered? I wish to quote a passage from a recent address by [1]Professor John Dewey on this point. He says, "Imagine a history of the teaching of the languages which should read like this: 'The later seventies and eighties of the nineteenth century witnessed a remarkable growth of the attention given in high schools to the languages. Hundreds of schools adopted an extensive and elaborate scheme by means of which almost the entire linguistic ground was covered. Each of the three terms of a year was devoted to a language. In the first Latin and Greek and Sanskrit were covered; in the next French, German, and Italian; while the last year was given to review and Hebrew and Spanish as optional studies.' " This imaginary picture by Dewey vividly illustrates the position of science at the present time.

How has it happened that the four sciences are arranged as they now are for the order given above is the usual one? Is it due to grading, forming a graded course in any strict sense of the word? I think not. Any one acquainted with high school science work knows that this arrangement depends upon other factors and not upon anything inherent in the subjects themselves. Take chemistry and physical geography, one usually given in the fourth year and the other in the first year. Chemistry could be adapted to first year grade just as well as physical geography so far as anything in the subject itself is concerned. But it happens that chemistry requires a more expensive laboratory and small classes, while physical geography requires a relatively less expensive equipment, is less expensive to run, and larger classes can be handled. Botany and zoology do not

1 Science, Jan. 28th, 1910, page 124.

necessarily depend upon anything taught in physical geography. Physics is given late in the course of study because the college requirements are so stiff that the work cannot be done in the first year. In fact the physics teachers of Chicago find it easy to arrange a course in physics for a proposed first year general science course. I think we can take it as proved that the sciences do not form a graded course comparable with courses in other departments and that the present arrangement is due primarily to extraneous factors such as cost of laboratories, size of classes and college entrance requirements.

It cannot be said, however, that school officials in planning courses of study consciously intended to slight the sciences. The fault is largely due to the newness of the sciences themselves. There has been action and reaction both in content and in methods of teaching of the sciences, and the end is not reached. The present laboratory method of teaching science in secondary schools does not date back two decades, while the classics have had the advantage of centuries of teaching, in which a great body of principles and methods has been firmly established. But it appears that school authorities have settled down to the belief that this fragmental practice of teaching science is sufficient, for we see a great uniformity in courses of study in this respect. The only straw that indicates a measure of dissatisfaction with the present arrangement lies in the agitation for general science courses in the first year of high school. A few schools have already established such a course.

A good test of the inadequate organization of the science courses is the manner in which the new courses of applied science are being added to the curricula of many schools. I refer to domestic science and agriculture. One would naturally expect that when these sciences are added to the curriculum of any school, they would be articulated with the existing courses in pure science. Before a pupil enters upon a course in an applied science, he ought to have received training in scientific method and habit of thought by studies in pure science, preferably of course in those sciences that underlie the applied science in question. Thus chemistry and botany at least should precede or accompany domestic science courses and all the biological and physical sciences are necessary to adequate teaching of agriculture.

But instead of an attempt to establish well graded or correlated courses of this sort, in which the pure sciences are prerequisite to or coordinate with the course in applied science we find that the new courses are usually being added without any reference to existing courses in pure science. Among the 40 courses of study I have examined, only two have any specific requirement of a pure science as a prerequisite. In Chicago, a four-year course in domestic science is being planned with no requirements in other sciences. Such extended courses in applied science must of necessity repeat, in a more or less complete way, science work which is already being done in the pure science or might be done readily if there were concerted action. This is surely a waste of effort.

But the case with agriculture is much stronger. We may have agriculture of a sort, but not "scientific" agriculture without the training and facts yielded by the pure sciences. Yet so-called courses in agriculture are being added as if the science were wholly unrelated to other sciences. Often these courses are placed in the early years of the course of study, where it is not to blame for the way it is being done. The arrangement any preliminary training in science. The result is, of course, a very superficial and unscientific kind of training.

But, after all, the school officers who are placing these new courses in the curriculum in reponse to the demand for them are not to blame for the way it is being done. The arrangement of the pure science courses does not offer any chance for the development of well graded courses in the applied sciences. Chemistry, which is needed in both agriculture and domestic science, is given in the fourth year in most schools and physics in the third year. Neither of these studies as now given can be utilized.

Another testimonial to the inadequate and unscientific organization of science in secondary schools is seen in the establishment of separate schools of agriculture and other industrial and technical schools of secondary school grade. These schools are a waste of the resources of the state, for they duplicate the regular schools in all respects save the one department. They are deterimental also in developing a false notion of the relative importance of the various departments of learning. The establishment of these schools is direct condemnation of the existing systems in the regular schools. The reason is not far to seek. The curriculum of the average school is not flexible, on the contrary it is so fixed that needed changes for adjustment to new relations cannot be made without a serious fight with the "ins." Rather than have this fight with an inflexible system, resort has been made to separate schools. Those who have the interests of the public high schools at heart should see to it that there is proper response to the demand for the teaching of agriculture and other industrial subjects in high schools. It should be met by honest endeavor to adjust old relations to new demands, else separate schools are bound to come with consequent division of funds and effort. I may add here an interesting fact in our experience in botany classes in Chicago. Of late, boys in our botany classes are strongly attracted by the advantages offered in scientific agriculture, forestry, and sanitary science. This movement is quite marked though we give only one year of botany with little that suggests agriculture in it. It is a trend country-ward from the city of city youth, in contrast with the usual movement.

We may now summarize the points I have made with respect to the position of science in secondary schools. First, the time usually given to science is very small in comparison with the importance of the subject and in comparison with the cultural subjects, averaging only one-half to one-third the time given to foreign languages alone. Secondly, the science courses as now planned are fragments of larger subjects and not enough time is spent on any one of them to secure good results either in disciplinary training or in information. Third, the science courses do not form a graded orderly development of knowledge such as we find in other departments. Each year's work is a detached piece and contributes but little to any other year's work in science. In consequence of the limited time given to each science, there is an attempt to cover too much territory in the allotted time. The pupil, instead of feeling the growth of power and grasp of the subject, is apt to be overwhelmed and paralyzed by matter that he cannot assimilate. Fourth, the pure science courses are organized in such a way that courses in applied science cannot be articulated with them and cannot take advantage of the expensive laboratory equipment of the pure sciences. Fifth, the inflexibility of the curriculum and the inadequate organization of the science courses have resulted in the establishment of many separate schools of agriculture and other industrial sciences.

It is not within the province of this paper to propose remedies for the cure of these defects. If a solution of the problems were easy, it doubtless would have been hit upon long ago. In closing, however, I would like to suggest what I think are the lines the reorganization of science must tae. These lines are first, foundational science in the first year of the high school; second, more time for each of the pure sciences; third, courses in applied science should be articulated with the pure sciences; fourth, all high schools in towns and cities tributary to agricultural districts should have a carefully planned course in agriculture and sufficient farming land for practical laboratory work.

It has been indicated that elementary physics and chemistry should be given in the first year as a foundation for courses in applied sciences and for the pure sciences as well. I would suggest a half year of physical geography, made less technical than it is usually given, followed by a half year of elementary physics and chemistry, this to be perequisite for all science courses, or a full year of general science consisting of physical geography and biology the first half and physics and chemistry the second half. In this latter case a more advanced type of physiography could be given later in the course. Physiology, now required in the first year, should follow zoology in the third year, but if it cannot be taken from the first year then it might be given without home work in informal lectures on hygiene and physiology, as an extra, time being given for it from the home work of all the other studies of the first year. It is now usually given in a perfunctory manner from a text-book and the method I suggest would be more dignified and beneficial, especially if physicians were invited in to give many of the talks. By this or some similar device the continuity of the science courses could be preserved.

Botany and zoology occupy at present an advantageous position that probably cannot be bettered. I would, however, give two years to each. The second year in botany could be given to systematic and economic botany, preparing the way for agriculture. A good second year's work in zoology would be formed by giving a half year to study of insects and economic zoology and a half year to vertebrates with special reference to physiology, including human physiology. In physics there is plenty of important work in electricity and other topics. But these are merely suggestions of my own. The great need is for careful study of the situation and experimentation with a view to improving not only the organization of the courses but also the methods employed in presenting the various sciences.

No one can justly say that this proposed increase of the science would burden the course of study for we have only to look to the foreign language courses to get a refutation of such a charge. The cost would be but little greater, nothing at all except perhaps in physics. The added time for better developed courses and the cutting out of hurry and scrimping will add dignity, interest and attractiveness to the courses in science and greatly increase their value. It has been found in the past that increased facilities for education always meet a prompt response in increased patronage. So with increased facilities and saner methods would come greater appreciation of science and still greater appreciation of the work the high schools are doing for the people.