REPORT OF THE COMMITTEE APPOINTED TO INVESTIGATE THE RELATIONS OF THE PURE AND APPLIED SCIENCES IN HIGH SCHOOLS.

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That there may be no confusion with respect to the purpose of the committee, I shall quote from the resolution adopted at the last meeting of the Academy, in which the appointment of the committee was requested. I quote the following:

"Inasmuch as the demand for industrialism in education has become widespread and is causing the addition of many new courses in applied science to the curriculum of the high schools and the readjustment of the established courses in pure science; and,

"In view of the fact that there is little data at the command of educators which might enable them to reorganize the work in science on correct lines without risk of serious mistakes fraught with danger of disaster to both the pure and applied sciences,

"Your committee recommends that the Academy appoint a committee of five members to investigate the practice of secondary schools in:—

1. The organization of the applied sciences.
2. The correlation of the pure and applied sciences.
3. The adjustment in the pure sciences to meet local conditions and satisfy the demand for practical courses."

After considerable study to find the best method of attacking the work, the committee decided that it could be accomplished best by a division of the investigation and assigning part to each member of the committee. The following subtopics were decided upon:

1. The effect of the demand for applied science upon the pure sciences in ordinary high schools where no courses in the applied sciences are given. 2. The relations of the pure and applied sciences in schools where both are taught. 3. The relation of these sciences in authorized agricultural high schools. 4. Their relations as shown by analysis of text-books of agriculture. 5. The preparation of teachers for the science work of high schools.

Unfortunately for our scheme of work, two of the members of the committee found that they were unable to do their work. To remedy this, the fifth topic just read was dropped for the present, and the second is included in my report, since the first and second topics are closely related.

I shall retain our original division of the topics in my discussion and consider first the effect of the demand for industrialism in education upon the courses in pure science in the ordinary high schools. The demand comes under various guises, such as "practical courses," "vocational courses" and "applied courses." Within the last two or three years great pressure has been brought to bear upon teachers of the pure sciences to modify these courses and make them more "practical," as it is usually put. How this pressure has been met, is the question which I have set myself to answer in so far as the scope and means of such an investigation as this can determine.

It seemed best to begin by studying the situation in Chicago, since I am well acquainted with the history of science teaching in this city from the time of the inauguration of modern laboratory methods, and since also the evolution of science teaching in Chicago is undoubtedly similar to its evolution elsewhere, except that it is slower because of the larger bodies of people to move.

There has been a slow evolution in methods of teaching the various departments of science from the very beginning of the establishment of the laboratory. The present agitation has only served to accelerate somewhat a movement already in progress. At first there was insistence upon strict scientific methods—such as the inductive process of observation and inference. A text-book open in the laboratory was strictly forbidden. The study of types with the emphasis on morphology was insisted upon. The order of study was always evolutionary. Even the laboratory tables were copied from the style found in college laboratories. In fact, the entire course was modeled on the college course—simply a slightly modified edition of the college course. The tendency has been away from this hand-me-down college work toward something specifically adapted to high school needs, —a high school course in science suited to the experience, ability and needs of the high school pupils. I think I can illustrate just what this progress has been by taking one of the high school sciences and comparing a former course used in Chicago with one recently adopted. For this I shall take botany, since in most or all of the other sciences, whether or not the experiences of the home and daily life are utilized, is a matter of laboratory practice in the application of the topics of study, while in botany the topics themselves give a hint as to the method used. In physics, for example, the topics electricity, heat, light, etc., will appear in all courses, no matter what the treatment, and only a study of the methods in use in applying the topics will show what progress has been made.

For the purpose of this inquiry it will be sufficient to compare two courses of study for botany—one dated June, 1908, and in official use since that time, the other recently adopted for future guidance.

A comparative study of these two outlines shows that in the earlier one the year's work was divided into two parts corresponding to the semesters, one occupied with a survey of the plant kingdom taking up the groups in evolutionary order, the other, usually given in the second semester, dealing with the seed plants and outlined in structural order. Theoretically this looks like an ideal plan, and it appealed to college men who write text books of botany for us and to teachers of botany fresh from the university, as the only course to give. But we who are in the business of teaching botany in high schools had difficulties in applying it. Our pupils were not interested, little enthusiasm could be aroused—many pupils failed—in fact, only the brightest pupils got anything out of the first semester's work. The second semester's work was needed to restore interest lost in the first half year's work, and even that dealt with structure to such an extent that the interesting spots in the course were in danger of being lost sight of. The work on the local flora in the spring was the only thing that saved our classes in botany from extinction. We turned out few botanists.

As soon as the average teacher realized what was happening, he began to inject into the course various features, mostly in the line of field and home studies, to add interest and appeal to the experience of the pupil. The most popular of these were studies of fall flowers, leaves, trees, woods, and various studies of the commercial uses of plants and plant parts.

Turning now to our recently adopted course, it is easy to see how this has finally worked out. It will be noted at once that the studies of plant groups occupy only about half of a semester, instead of an entire semester. Evidently, detailed studies of structure must be omitted in using this course, since there will not be time for such work. The title itself is quite illuminating, indicating that the laboratory is not the only place to study botany. It is interesting to note various topics not found in the old course, all of which appeal to the human interest of the pupil, such as

*COURSE IN BOTANY.
(In effect Sept., 1908.)

1. A laboratory course, following the authorized manual, including *first-hand* notes and drawings.

No. lab. periods.	Branch or Topic.	Type—careful study.	Comparative study.	Experiments and observations in physiology.
8	**Algæ.**	Pleurococcus. Spirogyra.	Vaucheria. Fucus.	Osmosis. Photosynthesis. Response of cell contents to alcohol, iodine and salt solution. Necessity of soil salts.
8	**Fungi.**	Yeast. Mucor.	Microsphæra. Mushroom.	Conditions for growth. Need of food.
1	**Lichens.**	Lichen.		
7	**Bryophytes.**	Marchantia. A moss. (Complete life history.)		Power of revival after drying.
12	**Pteridophytes.**	A fern (both generations).	Equisetum. Lycopod.	Grow fern spores.
4 8 12	Gymnosperms. Monocotyls. Dicotyls.	Pine. Lily.	Some other monocotyl. A crowfoot; A rose; a legume; A violet; a figwort; A composite.	Osmosis in seeds; in root hairs; in root (carrot exp.). Photosynthesis, need of light; need of carbon-dioxide; product. Circulation.
10	Seeds and seedlings.	Squash. Bean. Corn.	Five other seeds collected by the pupil.	Seed germination, conditions of as to light, water, heat, ai and external plant food. Place of growth in seedlings, root and stem. Respiration.
5	Roots.	Oat. Bean. Carrot.	Anacharis roots. Clover roots.	Response to stimulus. Root pressure. Food storage.
8	Stems.	Cottonwood. Ash.	Grape; trillium; Wild cucumber; Potato; onion.	Water content, soil, green wood, herbs, fruits.
12	Leaves.	Geranium.	Solomon's seal. Clover; ash.	Transpiration, rate and amount. Wilting and restoration. Use of protective coverings.

* Condensed from official bulletin of Board of Education.

BOTANY.

LABORATORY AND FIELD COURSE. 1b. (First Semester.)
(In use Sept., 1912.)

Topics.	Suggested Subtopics.
Fall flowers	Principal types of common wild and garden flowers, especially the compositæ. Insect pollination.
Leaves	Work of leaves. Light relation of leaves. Identification of trees by their leaves.
Weeds	Types of weeds and their characteristics. The struggle for possession. Collection of common weeds.
Seeds and fruits	Types of seeds and fruits; methods of distribution. Collecting seeds; planting tree seeds.
Preparation of plants for winter.	Trees, perennials, biennials and annuals considered in this relation. Bulb culture.
Forestry	Identification of trees in winter conditions. Planting and caring for trees; forestry. Enemies of trees.
Algæ	The cell; plasmolysis. Types of algæ showing development of plant body. Types of reproduction; establishing home aquaria.
Fungi	Life history of a fungus. Types of fungi from an economic standpoint. Bacteria.
Liverwort, moss, fern, pine	Evolution of the plant body. Spore reproduction; the seed.
	1a. (Second Semester.)
Seeds and seedlings	Germination; the seedling. Respiration; response to stimuli. Seed testing; food storage; uses to man.
Roots	Types, modifications. Food storage; uses of roots to man. Functions of roots; soils and fertilizers.
Stems	Types, structure and modification. Work of stems; uses to man. Woods; identification and collection.
Leaves	Structure, modifications. Work of leaves; economic uses.
Gardening, window and outdoor.	Planting rules, planning garden and homeyard. Garden accessories, hot beds, cold frames, etc. Types of garden plants; propagation of plants, cuttings, grafts, offsets, etc.
The flower	Structure and function by means of a typical flower.
Local flora	Types of flowers, flower families. Wild flower collection, flower calendar. Use of keys; how to make an herbarium.

fall flowers, preparation of plants for winter, forestry, gardening, local flora, etc.

Another very interesting and significant feature is the comparative flexibility of the two courses. In the old course the amount of time to be given to each subject is stated in hours. No such statement is to be found in the new course. The types in the old course are all stated positively, while in the new course the heading reads "suggested subtopics." Again, in the statement accompanying the new course, the teacher is given entire liberty with respect to the order in which the topics shall be taken up. The first course is arbitrary and inelastic. The new course is flexible and easily adjusted to any teacher's special needs.

The trend has been away from a strictly scientific development of botany which did not recognize the pupil and his interests to a flexible course, where the purely scientific development of the subject has been subordinated to the development of the pupil's interest in botany. The scientific aspects are not lost by any means, but they are not the sole thing now.

I have given a good deal of time to the study of the development of botanical teaching in Chicago, because it seems to be typical of the trend in all the pure sciences. It will therefore not be necessary to give much time to a consideration of the other sciences. Zoölogy has experienced like changes in method indicated by the use of the insects as an introductory study and by the dropping of the echinoderms from the course. This last was not done without a struggle, for the impulse to take up the groups one after another, omitting none, is very strongly rooted in the minds of zoölogy teachers.

In physics there is consistent effort to make application of the laws and principles of the science to problems of everyday life. In chemistry, analysis of food adulterants and other articles used in the home give the needed relation of the subject to the pupil's experience.

It would not do to assume that conditions in Chicago necessarily resemble those in other places. I, therefore, undertook an investigation to ascertain how the pure sciences are being taught in various other parts of the country. Manifestly, this could not be done by examination of courses of study, and so I prepared a brief questionaire which I sent to representative schools in Illinois and other States of the middle West, and a few to the extreme West. The returns were fairly satisfactory, considering that it required the combined reports of teachers of four departments.

For botany and zoölogy the following questions were asked: 1. State in order as given by you the topics and groups of plants (animals) taken up during the year and the time allowed for each. 2. Upon what do you place most emphasis? 3. What, and how much, outdoor work do you do with your classes? For physics and chemistry there were two questions: 1. State in order as given by you the topics taken up during the year. 2. Do you do any so-called "practical work" with your classes? If so, what?

A tabular resumé of the reports on these courses of study has been prepared and is appended to this paper. While the number of reports is not great, the schools included in the report represent a wide variety and are representative schools, so that it is probably safe to assume that their courses represent the prevailing tendencies. Wide variations are shown, especially in botany, but on the whole certain things stand out clearly, marking what we may call the attempt to relate the teaching of the sciences to the experience of the pupil.

In botany, as has been indicated, there is wide divergence, but it can readily be seen that the tendency is away from the evolutionary type method. It is also quite evident that there is as yet no settled conviction as to what should take its place. In zoölogy the insects are universally chosen for beginning the work and receive the greater share of the time. There is not much indication that the mammals are receiving a fair share of attention. If economic importance and nearness to everyday experience are to be controlling motives, then one would expect to see more time given to studies of mammals. The reports show on the whole considerably greater uniformity of practice than with botany.

The reports upon physics and chemistry did not give much of value on the first question so far as concerns this paper, and no tabulation of this portion has been made. The reports on the second question show almost unanimous agreement in giving the experiments a practical bearing and, and in the case of chemistry, in introducing many experiments with substances used in the home. Questions were sent out for physiography, but the reports did not seem to have much bearing on the question under discussion and have not been tabulated. It is fair to say for those making reports that it was found necessary to condense the reports as much as possible for use in the tables. Some of the reports were quite extensive and deserving of publication in their complete form if space had permitted.

Considering the reports as a whole, it will be seen that there is a decided tendency toward emphasizing the aspects of each subject that come within the experience of the pupils in everyday life. In some cases it seems to have been carried to excess, notably with tree studies in some courses in botany, and possibly in some of the courses in chemistry. The important principles of each subject should never be lost sight of, no matter what course is given, and I judge that there is danger of this in some cases. The movement, however, seems to be a healthy one on the whole and for the good of science insofar as it appeals to a greater interest on the part of pupils and their parents. That it is a progressive movement, in which some schools have made much greater progress than others, is also evident, and what we should expect and wish for.

I shall now take up my second topic, namely, the relation of the pure and applied sciences in high schools where both are taught. There are practically only two applied sciences which have been incorporated in high school curricula to such an extent

OUTLINES OF COURSES OF STUDY IN BOTANY.

Place.	Time sem.	Course.	Emphasis placed upon.	Field work.
Menominee, Wis.	2	Leaves, flowers, fruits, seeds, stems, 8 weeks; corn plant, oat plant, potato plant, 3 weeks; bacteria, 2 weeks; algæ and fungi, 6 weeks; liverworts, mosses, ferns, 3 weeks; spring flowers, about 12 weeks.	Corn, bacteria, fungi, spring flowers.	About 4 trips.
Minneapolis, Minn.	2	As in Coulter's text book of botany. Higher plants, 6½ months; fungi and bacteria, 1 month; algæ, mosses, liverworts, ferns, 6 weeks.	Trees, weeds, economic factors.	One lesson each week during spring and fall.
Detroit, Mich.	2	First semester, life history of angiosperm, plant,—seeds, seedlings, roots, stems, leaves, flowers, fruits, a few common families. Second semester,—life history of typical forms of algæ, fungi, moss, ferns. Preparation of herbarium. Study of stem structure and woods.	Development of power to observe, think and correlate facts of plant life, relation of plants to surroundings.	Study habits of plants—identification of native and shade trees.
Aurora, Neb.	1	1. Seed, roots, stem, leaves, fruit, flower. 2. Physiology of the above. 3. A brief view of ecology. 4. Economic importance of plants. 5. A brief study of cryptogams.	The structure and physiology of common flowering plants found in our neighborhood.	One excursion.
Quincy, Ill.	2	1. Plant relations. An introduction to forest trees, collecting, drawing, and mounting woods, foliage, leaves and seeds. 2. Plant structure. Collecting, drawing and mounting 25 flowering plants.	Ecology.	One period each week (2 hrs.).
Saginaw, Mich.	2	Leaves 10 weeks, stems 6, roots 4, seeds 4, germination 2, the cell 1, algæ 2, fungi 2, mosses 2, ferns 2, flowers and fruits 5.	Structure and functions, classification trees and shrubs, cultivated plants, alternation of generation.	Fall and spring, 20 periods in yards and parks.
Kansas City, Mo.	2	Flowering plants 4 weeks, algæ 4, fungi 6, bryophtes 1, pteridophytes 1, spermatophytes 8, plant processes 4, plants of economic importance, products, etc., 12 weeks.	Evolution and economic importance.	Several trips during fall and spring. Assigned individual work.
Crookston, Minn.	2	Anatomy and physiology of plants 13 weeks, ecology 8 weeks, cryptogams with emphasis on parasitic fungi 7 weeks, classification and preparation of herbarium 4 weeks, reviews 4 weeks.	Ecology, economic importance, work of plants, recognition of common plants.	Excursions for identification of weeds and other plants, collecting trips.

Monmouth, Ill.	2	Leaves, stems, roots—germination of seeds, 35 periods. The groups algæ to gymnosperms 29, angiosperius (general) 9, flowers and insects, seed dispersal 5, monocotyls 5, dicotyls 12, plant breeding, forestry, plant associations 4 periods, collect and mount 20 wild flowers, analyze 15.	Structure and adaptation in field and laboratory studies, economic importance.	Group work under teacher's direction. Collecting specimens.
Lansing, Mich.	1	Entire time given to flowering plants, 3 weeks on analysis flowering plants. Aim to make nature lovers of pupils, not scientists.	Plant as an individual in a certain relation to its environment.	Study of a selected tree throughout season. Collecting specimens. Volunteer work.
Indianapolis, Ind. Shortridge H. S.	2	Identification of trees, forestry studies as field work. Algæ 6 weeks, fungi 5, liverworts, mosses, ferns 6, pine 1, seeds and germination 4, roots 2, stems, 3, buds 2, leaves 2, flowers 5 weeks. Much practical work in gardening, forestry, fruit culture, flower calendar, etc.	Economic applications. Acquaintance with common plants.	Five required trips, others optional. Collecting tree leaves, 30 required, making flower calendar of 40 to 260 plants.
Ottawa, Ill. Township H. S.	2	Thallopytes about half semester, bryophytes and pteridophytes rest of semester. Spermatophytes spring semester. Some ecological work is given and lasts 8 to 10 weeks, given to determination of species of plants 3 hours per week.	Evolution of plant life and physiology of plants.	Ecological work and identification of plants.
Kewanee, Ill.	1	Four groups, mophological study 7 weeks, physiology of angiosperm types 6 weeks, ecology of region and some agricultural problems 5 weeks.	Physiology and ecology.	Very little. Classes too large.
Cedar Rapids, Iowa.	2	1. Field and laboratory study of weeds, seed dispersal, identification of 30 common weeds. Relation of flowers and fruits. Germination studies. Life relations, structure, physiology and ecology of roots, stems, leaves. Soil studies—Plant growing room provides specimens at all times. 2. Winter condition of buds, field study of trees. Plant groups. Plant families of locality. Pollination studies, plant breeding.	That phase of the work with which the pupils are most vitally concerned in their out-of-school life. For example, plant propagation, bulbs, grafting, condition of fruit buds in spring, etc.	Eight to ten excursions to fields during class hours. Much assigned individual work on special topics during entire year, often requiring daily outdoor studies.
Ft. Wayne, Ind.	2	1. Seed plants,—morphology, physiology and ecology of seeds, leaves, bud, stem, flower, fruit. Plant societies, classification, economic value of main groups. 2. Life histories,—algæ, fungi, mosses, ferns, club mosses, gymnosperms, angiosperms.	Morphology, evolution of plants, economic value.	Assigned work, pupils gather laboratory materials.

Place.	sem. Time	Course.	Emphasis placed upon.	Field work.
Ottumwa, Iowa.		1. Seed plants, leaves, 10 weeks (4 weeks to identification of trees by means of leaves), roots 2 weeks, stems 3 weeks, seeds 3 weeks. 2. Algæ, fungi, liverworts, mosses, ferns, flowers; identification of flowering plants.	Recognition of common trees, life process, food tests, etc.	Study trees. Pupils collect twigs of 50 trees. Ecological studies made. Assigned work.
Sycamore, Ill.	1	Seeds and their foods 5 weeks, roots 2, stems 4, leaves and light relations 3, algæ 1, mosses and ferns 2, weeds and struggle for existence 1, plant breeding 1.	The plant as a whole and as a part of the organic world.	Special topics assigned. Four excursions to study tree forms, light relations and plant distribution.
Paris, Ill.	1	Angiosperius 11 weeks, pteridophytes 3, fungi and algæ 2, gymnosperms 2.	Conditions of economic importance as soil, seeds, parasites, struggle for existence.	Individual field work—classes too large for class excursions.
Pontiac, Ill.	1	Atkinson Text—General plant anatomy, stem, leaf, seed, etc., 2 months. Work of plants, economic value, 2 months. Systematic botany, 1 month.	Work of plants.	Much of the last half month.
Waterloo, Iowa.	1	Stems and buds 3½ weeks, roots 1, seeds and germination 2½ weeks, leaves 2, cryptogams 2, flowers and classification 4, fruits 1, leaves 1.	Physiology and ecology.	One or two trips to study plant associations and adaptions.
Aurora, Ill. East Side H. S.	1	Tree study 5 weeks, leaves, stems, roots, seeds and seedlings, comprising their anatomy and physiology, 15 weeks. Second semester—Bacteria 2, algæ 3, fungi 4, lichens 1, mosses and liverworts 2, ferns 2, flowers 2, weeds 4 weeks.	Economic importance.	None except tree and flower study, which is more nature study than pure botany.
Macomb, Ill.	1	Seeds and seedlings 2 weeks, roots, stem, leaves, flowers, fruits, including functions and reactions to stimuli, 10 weeks, algæ 1, fungi 1, bryophytes 1, pteridophytes 1, gymnosperms 1, herbarium and classification 2 weeks.	Physiology of the higher plants.	None.
Waukegan, Ill.	2	Structure and functions of seed plants (except flowers), 8 weeks; evolution of plant kingdom, 12 weeks; ecology and economic value fruits and seeds, 4 weeks; local flora, classification and herbarium making, 12 weeks.	Fitness of plants to live in their environment.	Materials gathered. Most work in spring.
Streator, Ill.	1	Activities, structures and relations of leaves 4 weeks, roots 1, stems 3, flowers and fruits 2, seeds and germination 2 weeks, dependent plants and bacteria 2, evolution and plant breeding 2, principal families of higher plants 4.	Plant as a living working organism. Identification of common plants. Economic relations.	Ten to fifteen periods.

Rockford, Ill.		Fall flowers and weeds, 4 weeks; light relations of leaves, leaves and fruits of about 45 trees, shrubs and vines, 5 weeks; microscopic structure of leaves, algæ, physiology of green plants, 7 weeks; bacteria and other fungi, 3 weeks; winter condition of trees, stems, structure, 5 weeks; germination, soils, seed testing, foods in plants, 4 weeks; mosses, ferns, conifers, 3 weeks; spring flowers, plant families, cross pollination, plant breeding, plant societies, 9 weeks.	Recognition of common plants. Physiology and ecology of plants. Materials used in laboratory. Make course in botany foundation for agriculture as well as for biological science.	Several during fall and winter for materials for class-work, flower calendar, and leaf and fruit collections. Weekly trips in spring.
OUTLINES OF COURSES IN ZOOLOGY.				
Jacksonville, Ill.	2	Insects, protozoa and other insects, typical invertebrates, vertebrates, 12 weeks each. Botany and zoology taught alternate years. General science first year.	Animals harmful to crops, orchards and gardens. Animals useful to man. Birds.	All materials studied in laboratory collected in field trips. Birds studied.
Detroit, Mich.	2	Insects,—collect and identify 6 or 7 orders; life histories and economic value of common forms, 6 to 8 weeks; protozoa annelida, mollusca, crustacea rest of semester. Vertebrates,—lower chordates, pisces, amphibia, reptilia, aves, mammalia, 4 to 5 weeks each on birds and frogs.	1. Same as in botany. Applying knowledge gained in study to everyday life.	So far as possible study habits and hibernations of all forms, also relations of insects and birds to plant life. Identify 40-50 birds.
Aurora, Neb.	1	1. Typical specimens of each of the group. 2. Identification of laboratory specimens. 3. Economic importance of animals.	1. Identification of laboratory specimens. 2. Economic importance.	None.
Quincy, Ill.	2	1. Arthropods to protozoa. 2. Fishes to man.	Life relations. That zoology is a subject that pertains to "here and now."	Seeing "our little brothers" in their respective homes. At least one period each week during good weather.
Ottumwa, Iowa.	2	Insects, mollusks, spider, crayfish, earthworm, nereis, clam, starfish, hydra, protozoa, fish, frog, bird in order.	Morphology. Economic zoology. Collect 50 insects.	At least a week for bird study in spring. Insect work in fall.
Sycamore, Ill.	1	Insects 3 months, protozoa and hydra 3 weeks, crayfish 2, worms 2, frogs 1, fish and birds 2, mammals 1, summary and evolution 1.	Relation to environment and man.	Two or three class trips. Individual class trips.
Paris, Ill.	1	Arthropods 6 weeks, annelids 2, Echinoderms 1, mollusca 2, glimpse of lowest forms chorates 6, survey of evolution 1 week.	Habitat and distribution. Relation to environment. Economic importance.	Student must collect specimens of forms used in laboratory.

Place.	Time sem.	Course.	Emphasis placed upon.	Field work.
Pontiac, Ill.	1	Insects 6 weeks, other phyla 8 weeks, and ecology of animals 4 weeks.		None. Pupils required to secure most of laboratory material.
Waterloo, Iowa.	1	Insects 8 weeks, crustaceæ 2, worms ½ week, mollusks 1, echinoderms and coelenterates 1, amphibia and fishes 2, birds 1½, and mammals 2 weeks.	Economic importance, adaptation, function.	One field trip in fall.
Kansas City, Mo.	2	Insects 6 weeks, protozoa 4, coelentrates 3, worms 3, mollusks 2, arthropods 4, echinoderms 1, chordates 12, insects 4 weeks.	Evolution and economic importance.	Students collect most of the materials used in laboratory; 3 or 4 trips in fall and spring.
Danville, Ill.	2	Insects 6 weeks, the cell, mollusca to protozoa, vertebrates. Special study of birds.	Well done note book work, careful dissection of a few types, environment influences.	Collect 50 insects, and report on their mode of life.
Lansing, Mich.	1	Each of chief group taken up. Two weeks to general principles.	Insects and mammals, economic value.	Collections of insects; outlines for field study by pupils; a few voluntary trips.
Aurora, Ill. (West Side)	2	Insects 2 months, other arthropods 2 months, echinoderms, coelentrates, protozoa 1 month, vertebrates rest of year.	Economic importance; habitat and adaptations; enemies and allies.	Collecting material by class for use in laboratory.
Indianapolis, Ind. Shortridge H. S.	2	Time, 5 double periods per week, 10 months. Insects 6 weeks, cell and protozoa 3, sponges and coelenterates 2, worms 3, crustaceæ 2, fishes 4, amphibia 3, reptiles 1, birds 5, mammals 5.	Principles of biology. Growth development, parasitism, adaptations, economic importance, conservation of natural resources.	About 10 field trips, much individual work, bird records by all and an insect collection. Each pupil takes one field problem on which he reports.
Ottawa, Ill.	2	Insects 6 weeks, other arthropods 2, mollusks 2, worms 4, lower groups 6, vertebrates 18 weeks.	Insects and vertebrates, structure and economic relations.	About 1 hour a week for eight weeks.
Kewanee, Ill.	1	Insects, mollusca, porifera, protozoa receive most time, others briefly.	Economic value of animal and its environment.	One or two collecting trips.
Cedar Rapids, Iowa.	2	Insects 6-7 weeks. Follow this protozoa to vertebrates.	Environmental conditions, economic value.	Field work on insects and birds. Six to 8 field trips.
Denver, Colo.	2	Beneficial and injurious insects 6 weeks. Brief survey of each phylum. Special attention to local fauna, animal characteristics, struggle for existence, life cycle, mimicry, development, communal life, etc.	Study of animals, not books. Fresh material.	One class makes field trip each week—large amount of living material brought in and kept in laboratory.

"PRACTICAL" WORK IN PHYSICS AND CHEMISTRY.

Place.	Physics.	Chemistry.
Menominee, Wis.	Pupils work out special topics,—city water works, sewing machine, automobile, steam engine, gas engine, fireless cooker, etc.	Girls study food chemistry, boys cement, bricks, iron, soil, etc.
Ottumwa, Iowa.	Practical application of everything taught emphasized. Practical problems given. Visits to power plants, etc.	Practical exercises—acid in vinegar, chemical tests of cloth fibers, baking powders, etc.
Jacksonville, Ill.	Emphasize industrial side by visiting different plants relating to our subject.	Use food tests, baking powders, fermentation, fertilizers, fire extinguishers, photography.
Minneapolis, Minn. North H. S.	Emphasize practical and everyday side of each subject as much as possible.	Experiments in miniature of commercial manufacture of certain chemicals. Test for purity of water, ores, making mirrors, bleaching, dyeing, photography, ice manufacture, etc.
Detroit, Mich.	Use laboratory experiments which have a practical bearing.	Use many experiments having practical application, as fermentation. Tests of food, carbon compounds, distillation of coal and its gases, soda manufacture, also ammonia and acids. Attempt to bring out practical bearing.
Ft. Wayne, Ind.	All laws of physics are illustrated by practical examples.	Very little. Kept busy trying to give a fair understanding of chemical laws and the necessary elementary facts.
Saginaw, Mich.	In laboratory we do not. The classes are shown the practical application of the subject whenever possible.	Not so as to interfere with the scientific development of the subject. However, we use illustrative material drawn from the experience of the pupil whenever possible. Expect to start a special course for girls.
Moline, Ill.	All illustrations are made to apply directly to the commonest things of life. All experiments are made practical so far as possible.	Only enough theoretical work is taken up to make our work an orderly arrangement. No practical application neglected.
Elgin, Ill.	Determination of brake horsepower of a motor; heat content of city gas; heating and ventilation of our school building; rate of consumption of gas by gas stove; cost of gas and electric lights; study of gas engines.	Testing of water for impurities, dyeing, bleaching, fermentation, preservatives, testing foods for nutrients.
San Francisco, Cal. Mission H. S.	Experiments mostly qualitative to inductively present principles, not discover them. Practical applications to everyday phenomena we consider very important.	Our practical work bears on the chemistry of everyday life and home. We aim to let this take the place of the usual methods with the metals.

Place.	Physics.	Chemistry.
Rockford, Ill.	We try to see the practical application in every topic.	Test milk for fats, sugar, water, skimming and dirt. Analyze such things as sausage, pickles, coal, soil, fertilizer, stock feed, paint, baking powder, cocoa, extracts, whisky, butter, ice cream, blueing, etc. Our aim is to teach practical chemistry.
Kansas City, Mo.	As much as possible, especially in mechanic electricity and heat.	A very considerable amount,—soaps, hard water, baking powder, soda biscuit, water classification—bleaching, photography, etc.
Indianapolis, Ind. Shortridge H. S.	The work is made more vital and practical by introduction of interesting experiments, bearing directly upon the pupil's experience in daily life. (List follows; two long for this table.)	We attempt to train pupils to think and apply while dealing with the facts and theories of chemistry. (Details of this course cannot be given in this table.)
Denver, Colo.	At least half the work has practical bearing; the aim always is to make use of the past experience of the pupil, but this is difficult in mixed classes of boys and girls on account of the great difference in the experience of the boys and girls.	The work in qualitative analysis is certainly practical and in addition there are occasional visits to the smelters, chemical works, gas works, etc. Examinations of milk, baking powders, water, etc.

that they should receive attention in this report, and these are domestic science and agriculture. First, then, we shall consider the case of the courses in domestic science. For data I shall use a paper which I read to this body at its meeting in 1910, in which I made a comparative study of forty-three Illinois high schools.

Of the forty-three schools listed in this report—schools taken at random—44 per cent have courses in domestic science. Of the nineteen schools having domestic science in their curricula, seventeen have these courses in the first two years of the course with no science preceding which could serve to prepare the way for such courses. One school has its domestic science courses in the third and fourth, where it is possible that there might be correlation with the pure sciences. One other school has general science in the first year, with domestic science in the first three years of the course; there might be correlation here. A few schools have domestic science running through the entire four years. There might be some correlation in these schools, but probably not, since there could be no correlation in the first two years. From the above, it must be concluded that there is practically no attempt at correlation of domestic science courses with other science courses.

In discussing the correlation of agriculture with other sciences in the ordinary high schools, I am compelled to use data for the most part collected by others, since there was too little time for me to get data from original sources when I took over this topic. My principal source of information is a report made by C. H. Robison, entitled "Agricultural Instruction in the Public High Schools in the United States." This is a very extensive study of the subject and a very valuable one (made in 1910).

However, before analyzing the data to be gathered from Mr. Robison's report, it will be well to give some attention to the schools of this State which have courses in agriculture. At DeKalb a year's work in agriculture is given in the first year, thus treating it as an introductory science. At Princeton, agriculture is offered in the second year as an alternative for botany and zoölogy. It is preceded in the first year by physiography. At Freeport, agriculture is offered as an extra study—called the "agricultural club"—during the first two years. A note adds that "the work in botany, zoölogy, physics and chemistry is made practical for the study of agriculture." At La Salle an elaborate four-year course is offered in which agriculture and manual training are made to work together toward the one end. Only two pure sciences are offered in the agricultural course, namely, botany and zoölogy in the third year, and chemistry in the fourth year. Thus horticulture precedes botany, while zoölogy is given coördinately with animal husbandry. Physics is evidently included in the agricultural courses under various heads, as soil physics in the first year and farm-mechanics in the manual training course of the second year. This course seems to be well worked out, but the place of zoölogy and botany in the third year seems to be unfortunate, if the work is to be useful in agriculture. Apparently there is little correlation attempted in Illinois schools, except at the Freeport school, though an external study of courses cannot, of course, be conclusive.

Turning now to the data obtainable from Mr. Robison, the only point which I shall attempt to make is that of the correlation of agriculture with other sciences. Is there any attempt at correlation, or are the courses in agriculture put in where most convenient, or, perhaps, put in the first year to attract students from the farm—as a sort of bait? Mr. Robison has data from about one-third of the high schools in the United States then giving agriculture in the curriculum—enough, as he says, to indicate the "current practice" of the schools. Out of 104 schools which give only one year to agriculture, 49 place it in the first year, which, of course, renders correlation with other sciences impossible. Thirty-one more schools place agriculture in the second year, in which case it is possible to precede it by physiography, a science with which agriculture has comparatively little in common. If we add these two classes of schools together, we find that in 80 out of 104 schools reporting there can be but slight correlation with other subjects. Using other data, we find that agriculture is preceded by physical geography in 72 out of 108 schools reporting; preceded by botany in 33 schools; by zoölogy in 5 schools; by physics in 16 schools, by physiology in 17 schools. By these figures it is seen that the studies most useful to agriculture are least likely to precede the subject.

It does not seem necessary to quote further. Probably the lack of some settled plan of correlating the work in science in these schools is no more than is to be expected, considering the fact that agriculture is but just beginning to get a foothold in the curricula of high schools. But the fact that domestic science is also uncorrelated with sciences which might contribute to it tends to show a lack of appreciation that one science might help another—or a pure science help an applied science. We have no right to expect anything else, for the pure sciences themselves in the high schools, physiography, botany, zoölogy, physics, and chemistry, are each regarded and treated as entities having nothing in common. Each teacher puts into his department of science just what he pleases, with little or no regard to any other department. If between them all something fundamental is untouched, it is nobody's business. If this be true, and it cannot be successfully disputed, how could we expect a new science to be correlated with the older departments already in possession.

I cannot close my paper without some suggestions, hoping that they reach some sympathetic ears. My first suggestion is that when a new applied science such as agriculture is put into a curriculum, all interested in science in the school ought to be the ones to adjust it to its proper place and that the older departments ought to be correlated with the newcomer in such a way that what is already established in the school should contribute as much as possible to the new course. To be more explicit, why not let a general science course, or the physiography, botany, and zoölogy, contribute all they can to agriculture, and this can be a great deal; then agriculture can in its turn be made purely applied science, counting upon the help of other sciences to prepare the ground. The agriculture thus arranged would be of quite a different type from the mixed pure and applied science usually given. It would seem to be good business economy, to say nothing of educational economy, to let what is already established in the school do all it can, instead of running parallel courses—thus doubling the teaching and halving the size of the classes. Two years of agriculture rid of its pure science mixture should be sufficient if built upon two years of pure science in the first two years of the high school and correlated with the pure science of the last two years. If there can be but one year of agriculture, then it should be in the third or fourth year to make it most effective. This idea of putting agriculture in the first year is on a plane with the placing of stenography or bookkeeping in the first year—a bait to get the boy or girl into the high school and unworthy of an educational program. Studies should be placed where they belong in a consistent course. If the school is turning out self-reliant boys and girls, that is sufficient bait and the only inducement worthy of a school.

I cannot help thinking that in all this talk about practical courses, vocational training—continuation schools, industrial schools—there is danger of losing sight of certain fundamentals in education. Ought the boy or girl to be educated for a certain predetermined groove in society? Are we not in danger of doing this very thing, and is this not an effective method of perpetuating class distinctions? Is not such a course contrary to the well-being of a democratic form of government? These are things to be thought of seriously.