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Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

A Discussion of a Plan of a Scientific Course.

by C. E. Bessey
Ames. Iowa.

Read before State Academy Association
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A Discussion of A Plan of a Scientific Course.

Before beginning, I would have it clearly understood that this essay has nothing to do with the needless and unfortunate quarrel which has arisen between some of the teachers of Science on the one hand, and of the Classics on the other. Those who think there is cause for such a quarrel, and who imagine an antagonism between the languages and the Sciences, may fight it out if they choose; for myself, I see no necessary antagonism, and know of no cause for quarrel.

The main object of a scientific course of study is, as I shall assume in this discussion, to give that training which will prepare the man of rather more than average ability for successful labor in some of the fields of Science. It must not be expected of such a course that it shall make a man master of the sciences, nor even master of a single science, but that it shall give to him such training as will prepare him to pursue to the greatest advantage, during his post-graduate life, the study of one or more branches of Science, and to meet intelligently the difficulties which will arise while making his inves-

tigations. The proper work of the school and of the college, is to train the man for his work, to familiarize him with the methods, and to give him those habits of mind and body, which have proved most conducive to valuable results in the workers who have preceded him. The School of Science is not essentially different in this respect from other schools; the object is not so much to put the student in possession of great stores of knowledge as to give him the power to acquire them. Hence there must be laboratories of Chemistry, of Physics, of Biology, and of Geology; there must be libraries,

and museums, and collections of apparatus; for these are the materials with which the scientific man is to make his investigations. That course of study can not be called a course of training, which omits what [redacted] we are now in the habit of calling Laboratory Practice. The old motto "Science with Practice" is today the ruling maxim with our foremost science teachers.

Another object of a Scientif-
-ic Course, which is perhaps
not clearly distinct from the
former, is to arouse in the
young a love for plants and
animals, and a curiosity
about stones and fossils, the
wind, the snow, the rain, and
the thousand and one other nat-
-ural phenomena which too
often are entirely unobserved,
or if observed scarcely more
intelligently than by the wild Indian.

There are many boys and girls
who need but to be guided to make
close observers, or careful collect-
-ors. They readily learn to use
their eyes, and it is astonishing what
rapid progress they can make, and what
enthusiasm they are capable of exhibiting

While a teacher in the common schools, I saw some wonderful developments of this kind.

I once organized a class in Natural Philosophy in a school where the old routine of reading, writing, spelling, arithmetic, geography, and grammar had never within the memory of man been varied from. I gave the class a plainly written book, filled with excellent wood-cuts. Being an adept in whittling I constructed during some leisure moments many little pieces of apparatus for illustrating the topics taken up from day to day. As the school-room was merely a common single

room, the class recited in the presence of the whole school, and I may almost say that the whole school took part in that exercise. Grammar, Geography, Arithmetic, play, mischief, drowsiness — all gave way to intense interest. Even the little six- or seven-year-olds watched and listened with glistening eyes and attentive ears. My devices were all duplicated, and my experiments were repeated ~~morning~~ noon and night a hundred times. A mill in the vicinity was invaded night and morning by an eager crowd of boys, and no mechan-

-ical arrangement, from the big water-wheel down below, to the dusty pulleys and cog-wheels in the attic escaped them. A company of them took a twenty mile ride on a bitter winter day in order to examine the mechanism for reversing the motion of the locomotive engine. The country was ransacked by these embryo scientists, and old and forgotten apparatus was brought to light and made to contribute to our stock.

And yet this was in a common school, and the pupils were such as you may find in thousands of places in Iowa.

But this was not all; her enthusiasm was not expended upon Natural Philosophy alone. One morning a boy brought a little stone containing a fossil, and laying it on my table, asked what it was; I told him, and in an hour or so I made it the text for a little geological lecture to the school. Soon the stones began to come in, and some mornings my table would be literally covered with the contributions from my amateur paleontologists. In this again the whole school seemed to be interested. I shall not soon forget one little fellow, the only one whose eye

I could never catch while talking about the specimens before me, and whom I supposed to be utterly indifferent to all this scientific furore. One morning as I was walking alone to my boarding place, an hour or so after the close of school, as I rose above the crest of a hill, I saw in the distance some one, with a great stone held in his two hands, hammering vigorously a large ~~rock~~ stone by the road-side. I soon found that it was my pupil, and so intent was he, that he did not discover that he was observed until I approached quite near to him, when dropping his stone and seizing his basket, he

marched on with an air of the utmost indifference for me, or for rocks, or for fossils. And yet a day or two later that little fellow brought me a magnificent specimen of a fossil coral.

There is no question at all ~~as to~~ the possibility of introducing the Elements of Science into the common schools. It can be done, and, when properly done, with great profit to the pupils.

do you ask them, "when shall we begin to teach the Elements of Science?" Unfortunately the question can not now be answered as it should be. Were our teachers ready to do so, they should begin with the primary classes in the common schools.

There appears to be a great fear, on the part of some, lest the children's minds should not be ready for the reception of scientific facts: but the trouble is not with the children, they are ready to learn about plants and animals and simple machines, and have always been ready; it is the teacher who lags ~~behind~~ in this.

It is perhaps hopeless to expect, for a long time yet, that teachers in the common schools will be able to instruct their pupils in Elementary Botany, Zoology, and Physics: but it is nevertheless exceedingly desirable: and it is the duty of those controlling School affairs in the country, to bring about as rapidly as possible, the necessary improvement in the qualifications of teachers.

Do you ask <u>how</u> shall we begin the teaching of Science? Begin by making yourself well acquainted with the trees, the shrubs,

and the wayside herbs. the birds, the quadrupeds, the frogs, and the snakes in your neighborhood and then take these as your subjects, not for the old fashioned "object-lesson" but for suggestive little talks. Encourage the natural curiosity of your pupils: lead them to ask questions about everything they see. Tell them frankly that there are a great many things you do not understand, but let there be nothing you do not wish to understand; possess this spirit yourself, and your pupils will certainly acquire it.

But a scientific course must include more than the sciences alone. The mechanic who has the greatest number of necessary tools, in the best order, can, other things being equal, do the best work: so it is in scientific work; the man who has at hand, and in good order, the greatest number of helps, will, in general, be able to do the most and the best work. The most skillful mechanic with poor tools can do but indifferent work, and in like manner, some one Agassiz, and a Huxley would have been unable to lead the scientific men of their times, had they been

hampered by poor preparation.

Science is mainly cultivated today by the German-speaking people, followed by the English, French, Italian, Russian, Scandinavian, Danish and other Continental workers, in probably something like the order I have given. The literature of the science of today is, consequently, scattered throughout the languages spoken by the principal nations of Europe.

Until within a comparatively short time, the records of all scientific work were mainly written in Latin, and it is still the custom in the

Biological sciences to write descriptions of species, and the results of certain investigations in this common language of the educated world. The man, therefore, who knows no Latin is crippled in his work, through being unable to use the valuable literature of the last century, as well as a not inconsiderable part of that belonging to the work of today.

It is then not too much to say, that any scheme of education from which the principal Continental languages, and Latin are absent, is imperfect. A full command of one language (the mother tongue) and

and ~~such command~~ a fair knowledge of Latin and ~~two~~ or three of the other more important languages I have mentioned, is the very least that can be allowed. An Englishman or an American should be master of his own language, for in it he will record the greater part of his work: he should in addition be able to read with reasonable ease Latin, German and French; if to these he can add Italian he will find open to him many valuable records with which he can ill afford to dispense. I would emphasize this point, the man who would enter the higher

departments of scientific work must not be mearly equipped in the languages.

A great wrong has been done to Science by many schools and colleges, which have established courses of study in the sciences, and have neglected the languages. [in those courses.] I have in mind some such courses of study, which have been reduced to the leanness of only a very little English, — and yet the framers of these courses hope to make scientific men who can compete with the better furnished students sent out by wiser institutions! What should we think of a Governor who

sent his troops into battle un-armed?

It is gratifying to know, however, that in this matter our Colleges are improving; an extensive examination of College Catalogues within the past month, shows that nearly all recognize the need of German and French in their courses in Science, and nearly if not quite two thirds add from one to three years of Latin. This indicates a healthy growth, and shows that the Scientific Courses in our Colleges are coming more and more under the control of men who know some of the demands of Science.

And now while talking about the colleges, I may as well offer some criticisms to which, despite their improvement, their scientific courses appear to me to be open.

(1) They are, with scarcely an exception, entirely too short to accomplish the best results. In some cases the attempt is made to crowd all science into four college years, taking the student upon his entrance at the point where he was left by the common school. In most cases five or six years are all that are allowed for the work, while in but one instance, out of a great number

which came under my observation, were seven years of study above the common school required of the candidate for the degree of Bachelor of Science.

When now we consider that in none of the Colleges are the facilities for scientific instruction complete.

(2) Time is wasted by the practice which largely prevails of taking up one study for a time, and then abandoning it for another and another, only to return again "after

many days" to the first. This want of continuity in study is, I am confident, one of the great-est evils found in our scientif-ic courses. It indicates the absence of a clear understanding on the part of those who framed such courses of the work to be accomplished: ~~on the part~~ and in its results it is apt to bring about the same con-fused notion of Science, in those subjected to such desultory train-ing.

No doubt there may be many excuses for this condi-tion of things: the small number of teachers, the want of adequate museums, labora-tories and apparatus, too com-monly the case in our Colleges,

have had much to do with determining what should and could be done. Herein our Classical courses are almost infinitely superior to those in Science; in the former the student, once started in his work, keeps at it, and wastes no time in the intermittent and desultory method of study pursued in the latter. In this matter the Science teacher must learn to be as wise as the teacher of the classics. It is to be a law which can not be broken without great harm to the pupil, that a study once taken up should not be laid down.

(3) Another serious fault in a large number of college courses is what I shall denominate weakness in the Senior year; that is I find that in fully two thirds of all the cases which have come under my notice, the scientific studies are mostly placed in the Sophomore and Junior years, so that in the Student's progress through college he finally passes beyond the study of Science. A more unwise plan I cannot imagine; were the object to not make scientific men, one could not well devise a method better suited to the work.

This fault, however, is not

confined to the scientific course, it is a common characteristic. Take up the courses of study, classical and scientific, which may happen to be at hand, run them through, and you can not help remarking upon their similarity in the last college year, and upon the general abandonment of a definite aim in the course. They lead nowhere, or perhaps we may say more properly, they all lead to the same unprofitable confusion in which we find "Butlers Analogy" "Psychology," "Evidences of Christianity", and other like matters as prominent ingredients,

What natural relation is there between the student's earlier training and the topics given him for study in his last College year?

The fact is, we go at this matter in the wrong way. Our half dozen or dozen professors are like so many specialists in house-building who, instead of all working together, work independently. The mortar maker, the hod-carrier, the wall-builder, the chimney builder consult no common plan, but perform their allotted tasks according to their individual convenience. The joiner makes doors and

windows when and where
he chooses, and so on the
building grows in its gro-
-tesqueries, until at the
end of so many years, with
no regard for the intended nature
of the building, a bell-tower
and a steeple are fastened
over it all.

We are now ready to give definite shape to the foregoing discussion by incorporating its ideas into a course of training in science. For reasons given above we will not lay out any work for the common schools, but will begin at the point where the student usually commences his high school studies, or his work in the preparatory departments of most of our colleges.

In framing such a course we must keep in mind several requirements, which may be briefly recapitulated as follows:

1. The Course must furnish facilities for acquiring a knowledge of Latin, German, and French, besides a full command of the English language.

2. It must provide for an early introduction of scientific studies.

3. It must provide that a scientific study once taken up shall not be laid down.

4. It must provide for Laboratory ~~work~~ practice or its equivalent, for every branch of Science, throughout the whole time it is pursued.

5. It must become stronger in Science from year to year, the last college year being the strongest.

The subjoined plan is presented as a Study for a course of training in Science; it is merely provisional; and yet I trust that it contains not so much of error but that it may be worthy of further study and improvement at your hands.

A Study for A Course of Training in Science.

First Year.

First (or Fall) Term	Second (or Winter) Term	Third (or Spring) Term
English	English	English
Latin	Latin	Latin
Mathematics (Alg)	Mathematics (Alg)	Mathematics (Alg)

(Note for bottom of page 32)

Note. Unless otherwise indicated each study has five lectures or recitations per week: studies having a less number of exercises are followed by a fraction which indicates the amount devoted to them. E.g. 3/5 means three lectures or recitations per week.)

First (or Fall) Term	Second (or Winter) Term	Third (or Spring) Term
History 3/5	History 3/5	History 3/5
Botany 1/5	Botany 1/5	Botany 1/5
Zoology 1/5	Zoology 1/5	Zoology 1/5

A Study for A Course of Training in Science.

First Year.

First (or Fall) Term	Second (or Winter) Term	Third (or Spring) Term
English	English	English
Latin	Latin	Latin
Mathematics (Alg)	Mathematics (Alg)	Mathematics (Alg)
Drawing (1 hr daily)	Drawing (1 hr daily)	Botany 1/5

Second Year

Latin	Latin	Latin
Mathematics (Geom)	Mathematics (Geom)	Mathematics (Geom)
History 3/5	History 3/5	History 3/5
Botany 1/5	Botany 1/5	Botany 1/5
Zoology 1/5	Zoology 1/5	Zoology 1/5

Third Year.

Greek	Greek	Greek
Mathematics (Trig)	Mathematics (Trig)	Mathematics (Trig)
Botany 1/5	Botany 1/5	Botany 1/5
Zoology 1/5	Zoology 1/5	Zoology 1/5
Chem. & Physics 2/5	Chem & Physics 2/5	Chem & Physics 2/5
Drawing 1/5	Drawing 1/5	Drawing 1/5

Fourth Year.

French	French	French
Mathematics (An. Geom)	Math. (Anal. Geom)	(Math. (Anal. Geom)
Botany 1/5	Botany 1/5	Botany 1/5
Zoology 1/5	Zoology 1/5	Zoology 1/5
Chem & Phys. 2/5	Chem & Phys 2/5	Chem & Phys 2/5
Geology 1/5	Geology 1/5	Geology 1/5

Fifth Year

French	French	French
Math. (Calculus) 2/5	Math. (Calculus) 2/5	Math. (Calculus) 2/5
Biology 2/5	Biology 2/5	Biology 2/5
Chemistry 2/5	Chemistry 2/5	Chemistry 2/5
Physics 2/5	Physics 2/5	Physics 2/5
Eng. Lit. 4/5	Eng. Lit. 4/5	Eng. Lit. 4/5
Geology 1/5	Geology 1/5	Geology 1/5

Sixth Year.

German	German	German
Botany 2/5	Botany 2/5	Botany 2/5
Zoology 2/5	Zoology 2/5	Zoology 2/5
Chemistry 2/5	Chemistry 2/5	Chemistry 2/5
Physics 2/5	Physics 2/5	Physics 2/5
Eng. Lit 4/5	Eng. Lit 4/5	Eng. Lit 4/5
Geology 1/5	Geology 1/5	Geology 1/5

Seventh Year.

German	German	German
Botany 2/5	Botany 2/5	Botany 2/5
Zoology 2/5	Zoology 2/5	Zoology 2/5
Chemistry 2/5	Chemistry 2/5	Chemistry 2/5
Physics 2/5	Physics 2/5	Physics 2/5
Geology 2/5	Geology 2/5	Geology 2 2/5

Eighth Year

Botany 2/5	Botany 2/5	Botany 2/5
Zoology 2/5	Zoology 2/5	Zoology 2/5
Chemistry 2/5	Chemistry 2/5	Chemistry 2/5
Physics 2/5	Physics 2/5	Physics 2/5
Geology 2/5	Geology 2/5	Geology 2/5
Science of Language 4/5	Sci. Lang 4/5	Sci. Lang 4/5
Logic 1/5	Logic 1/5	Logic 1/5

These eight years of study might be divided between the high school and the College, or between the Pre-paratory and the Collegiate courses in College. What should be the limits of the High School or preparatory work. I shall not attempt to decide: in fact it is a matter of no great importance. The High-School can certainly do the work of the first and second years; many of them can do good work in the third year, and the best of them may perhaps extend to the fourth and even fifth years. The College courses in each case would be longer or shorter as the preparation was less or more Extended.

If the High Schools will attempt to teach no further than their facilities for demonstration extend, there need be no difficulty in the matter.

I take it for granted that the High Schools are, or should be able to teach well the Languages, Mathematics, History and Drawing of the first four years; the difficulties will arise in finding means for properly teaching the Sciences.

The Botany of the first and second years should consist of general external structure, learned from the plants themselves. The pupil should be taught the authentic

common names of particular plants, and groups of plants. He should also practice drawing leaf- and other easy forms, and should from the first be encouraged to collect and preserve specimens. In the third and fourth years, the student should begin, with the aid of books, to learn the technical names, the classification and the flower structure of the plants in his neighborhood.

The Zoölogy of the second, third and fourth years should consist of similar work, and here again, the student should be encouraged

to collect specimens for himself.

I would perhaps go no further for the preliminary years: The method, it is readily seen, is that of learning from Nature, under the guidance of the teacher. The teacher must exercise an intelligent discretion; too little help given the pupil is often as bad as too much.

During the later years the training in Botany, Zoölogy and Geology should consist, aside from the lecture-room exercises, of laboratory and field work: at

least three consecutive hours per week being given to each. Chemistry and Physics should also have their laboratory facilities, not alone for simply repeating the experiments made by the teacher, but for original investigation as well.

I should say, before closing, that I have used the names Chemistry, Zoology and Geology in their most comprehensive sense; Mineralogy being included in Chemistry; Comparative Anatomy, Human Physiology and Human as well as Comparative Psychology in Zoology, etc. etc.

Hoping that the ideas brought forward in this Essay may not prove barren ones, and trusting that whatever of truth they contain may fall on good ground, I submit all to your candid judgment.

Sci Soc. Ames - Iowa 1

1870

In Selecting a subject for my talk this evening I have endeavored to choose such a one as would contain a hint or two which might prove useful to this young naturalist for some of the peculiarities he is destined to meet with

I have therefore collected a few facts relating to certain irregularities sometimes found in the flora of any country.

A careful study of the ordinary Manuals of Botany will show that in very few instances do plants have certain marked varieties common to certain localities. These varieties are often so marked as to puzzle the naturalist exceedingly. He is often at a loss to know whether to call a certain marked set of plants - a distinct species or but a variety of some other species.

This trouble is increased by the fact of certain unexplained irregularities in the appearance of the plants from year to year

Among these irregularities may be mentioned first that of the sudden appearance of a certain species in a locality where it had not existed before - or when it had been very rare - This sometimes occurs and when the new plant bears a close resemblance to an old species - it is a difficult matter to decide whether the new one is or is not entitled to be called a separate species -

As an example pallow permit me to call your attention to a case which came under my own observation -

In the Flora of Lansing Mich. the common spring plant called the Yellow Adders Tongue - is found in great abundance - This as you know is uniformly yellow - while the leaves of the plant are a mottled green - In the same Flora previous to the year 1869 the other species called the White Adder Tongue - had not been found more than two or three times within the last five years

This White species is described by Gray as being quite different from the Yellow - and he accordingly recognizes it as a different species -
A close examination shows a marked difference also. Certain parts of the flower seem uniformly to have a different form in the White from what they have in the yellow - This added to the difference in color has been considered as sufficient proof of its being a distinct species - Last year however some facts transpired which seem to destroy all certainty upon this point - Last Spring when the May flowers made their appearance the Yellow Adder's Tongues were found in great abundance as usual - but to the great delight of enthusiastic botanists the White was also found here and there - This was at first considered but as a rare streak of good luck - but it soon became evident that the white plant was in greater abundance than formerly.
But the wonder did not stop here -

~~By~~ Soon the white plant was found in a great many places where it had not been known before. Places where in previous years the Yellow alone had abounded - were last year filled with the white - not to the exclusion of the Yellow - but they were found in ~~considerable~~ astonishing abundance considering their former rarity -

~~As it is possible to~~

The question now arises - "Is the white plant a separate species from the yellow or only a variety?" as to its abundance would seem to imply - that it is a separate species - Whence came the seeds from which sprang up the plants of last year? It is possible to conceive of methods by which the seeds might have been distributed - but none of them seem probable. For example it might possibly be through the agency of birds - but the wide distribution of the plants would not warrant accepting any such explanations -

Then again it might be claimed that the abundance of rain may have

So flooded the land as to float the seeds to places where they had not been noticed before - But still this would not account for the astonishing increase in number - A few seeds may be floated by the water to new localities but there would be so much loss by this method of transportation that we cannot admit its probability in this case - It may finally be claimed that the seeds may have lain in ground - latent for years and that the very wet season brought about the proper conditions for the germination of the seed - This may have been the case it is rendered somewhat doubtful by the fact that the seeds of the Onion and Leek - which are nearly related - do not retain their vitality with any degree of certainty for more than a year or two.

Here then is the difficult point for the botanist - to decide between the probabilities of a mere variation occasioned by some unknown cause - or of a transportation or preservation of the seeds in methods similar to those I have cited -

Perhaps the only way to settle the matter now is to carefully watch the growth of both plants for a number of years— I am looking with a good deal of interest to the report from there when the plants begin to bloom again— Should the white plants be as abundant this year as they were last it will go a good way to show them to belong to a separate species— But if on the other hand they are again rare it will almost establish them as a variety—occasioned by some peculiarity of the ~~climate~~ [season].

But ~~dropping~~ [laying] this plant for the present aside allow me to give another example of the perplexities of the natural-ist ~~meets with~~

In the same Flora before mentioned is found the little early Spring plant— the Hepatica—or as it is popularly called the "Liver-leaf". Those of you who are acquainted with the plant remember the shape of its leaves— but for the benefit of those who have not seen the plant I will describe them—

They are three pointed or as we would describe them Botanically - three lobed - Occasionally the number of lobes is increased to five tho' this is comparatively rare -

Now a difference has been observed in the shape of the lobes - In some plants the lobes are sharp and that is they run to a point - while in others they are rounded - The variation I mentioned before - that of having five lobes instead of three is also found to occur generally with the sharp or rounded plants - The flowers of each are alike or at any rate very nearly so. The question now for the Botanist is this - "Shall we call these plants varieties of the same species - or are they really distinct" - Some Botanists have decided one way and some the other opposite. How can this be finally decided - It can not be done in one year - neither can it be well done by one person

A number of persons must observe the plants during several years, carefully noting the appearance of both plants - noting any differences they may possess - such as a difference in time of blooming - in the soil they grow in - in the shape or number of the parts of the flower, and particularly any variations from the two types of leaves which might indicate a gradation from the round lobed leaf to the sharp lobed -