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A study of the evolution of the course of study in high school botany

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A STUDY OF THE EVOLUTION OF THE COURSE OF STUDY IN HIGH SCHOOL BOTANY

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I. INTRODUCTION

A. General Statement

In this study it was necessary to set up a standard from which data could be taken. A table of the main divisions of elementary botany was arranged and the number of pages of each of the selected texts was recorded in the table. Then the writer ascertained the percentages of the number of pages from each text falling in the divisions of the table set up.

This study was made with the view of showing some of the previous trends in the course of study in botany at the high school level by an analysis of the textbook content over a period of forty-two years, and of making, from the textbook trend, suggestions for the future course of study.

The tendency today in curricular construction is to build on an enrichment basis and to generalize the subject matter instead of keeping it highly specialized.

This is a period in which a great deal is being done in the field of textbook and workbook writing. It would be profitable to know the direction that we are going even if we are not able to determine the destination. Oftentimes direction is indicative of destination. Certainly there will be a destination at which to arrive in the future or a better organized plan of procedure than at the present time. At least we have the opportunity of investigating the past and present trends in this field. There

has been more study and research devoted to general science and biology courses of study than there has been to courses in botany. The reason has been a good one. Seemingly, botany has not been taught to any great extent in the smaller high schools, and the fact that it has not been required on the curriculum for graduation in any of the high schools of the state except for the specialized curricula of larger high schools, naturally, has reduced participation in the study of botany, as such, in the secondary schools.

There seems to be a tendency to rebuild our high school curricula at the present time, that tendency being somewhat towards a widening science program which will ultimately tend to include more botany in the curriculum. Also there is strong effort being put forth in the field of State and Federal Conservation toward reforestation, founding of parks, game reserves, and the maintenance of the virgin prairie. This will necessitate more knowledge of plants toward two ends, the technical knowledge needed for the establishment of the above projects and in order that the masses may be able to appreciate this social tendency in education and society.

Many educators in the field of administration are coming to think that since we are engaged in living in a scientific world our course of study should be constructed more distinctly in that field. They are beginning to break away from the classical

curriculum to a goal of training in vocational tendencies which will prepare the individual to better adjust his living to the group in which he must not only perpetuate his kind but also be able to appreciate his habitat. David Snedden said, "We must have in our society today both the producer and the consumer, and the consumer far exceeds the producer group in number". In the past we have been so deeply interested in turning out the producer that we have somewhat neglected the consumer; consequently he has not had given him the proper background to make an efficient social creature of him.

The next question arises out of one of the primary aims employed by the expert in curriculum construction; namely, out of each subject or subject division what should be taught the ordinary individual?

1. Purpose of the Problem. The purpose of this problem is to show the changing tendencies of the course of study of botany at the high school level, as it is shown by the textbook content analysis in this study.

2. Problem Defined. The evolution of the courses of study in high school botany may be defined as the changes in the quantity of the various divisions of the subject matter offered in the course of study in elementary botany, as revealed by a sampling of the textbooks selected for this study.

3. Method of Study. The method used in the preparation of this work is a survey analysis of the problem. Several textbooks were selected which were published during a period from 1889 to 1932. An analysis was made on the basis of content by page and content by topic.

4. Sources of Data. The data for this study were gathered from a sampling of fifteen textbooks in elementary botany which have been or are adopted in high school botany in the United States over a period of about forty-two years. The major topics were chosen and the number of pages devoted to each topic was tabulated. These texts were collected from various high school libraries and the Indiana State Teachers College library.

B. Historical

Botany is that science which includes everything relating to the vegetable kingdom, whether it be a living plant or one in a fossil state. The name is derived from the Greek Botavn.

Botany, in the sense of material content, is one of the oldest of the biological sciences. But, like all other subjects, botany was not organized in its present form until very recently.

Plants in all parts of the globe have more or less attracted the attention of mankind from the earliest times. Solomon spoke of the trees, from the cedars of Lebanon to the hyssop on

the wall. The Chaldeans, Egyptians and Greeks were likewise early interested in plants, although at this date there was much controversy as to whether lower forms of plants in their development ever changed into animals. About 300 B. C. a plant history was written in which about 500 species of plants were described as being useful in the treatment of various diseases. Dioscorides, a Greek botanist and physician, wrote on uses for medicine. Pliny, in the first century A. D., described about 1,000 plants, many of which were well known for medicinal uses and values. Asiatic and Arabian writers took up the subject of botany to some extent, but little was done until the sixteenth century, or during the revival of learning. Otto Brunfels, of Bern, who has been called the restorer of science in Europe, in his herbarium, printed at Strassburg, gave descriptions of a large number of plants of central Europe. Then came William Turner, who is said to be the father of English Botany. In the seventeenth century, John Ray incorporated a system of classifications which indicated that botany was progressing as a science.

Robert Morison, head professor of Botany at Oxford, in 1669 published a plant classification in which he systematically arranged all plants into eighteen classes.

In the eighteenth century, a man by the name of Carl von Linnaeus, who is the founder of modern taxonomy of plants as we have it today, worked out an extensive system of classification.

This system was adopted by the French School of Botany and has become universal.

It is of no small importance that the changed opinion of Linneaus, combined with that of Jusieu, in regard to the relationship of the species of plants, was ultimately adopted without theological protest.

"The discovery by Goethe of the homologies of the parts, and by Linneaus of the organs of the sex in the flower, were important steps toward the modern theory of evolution of plant life."[1]

Botany was studied in the early schools more than zoology because the early botany was extremely practical in content, being an outgrowth of the study of medicinal herbs. Later it passed into the stage of development known principally as classification, the naming and description of the parts of habitats and medicinal properties. It was this descriptive and taxonomic phase of botany that found its place in the early schools. It seems to have been cultivated in schools for girls, where it was considered more as an accomplishment or a social grace rather than as a means of mental discipline.

"Botany emerges on the horizon from an educational dark

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[1]W. T. Sedgwick and H. W. Tyler. A Short History of Science (New York: Macmillan Co. 1929), p. 72.

age possibly with Asa Gray. His textbook published in 1856 made the subject both possible and popular in the schools. The main aim of Gray's Botany was acquaintance with the plants of the region."[2]

This type of botany sent the student into the fields where he became acquainted with a large number of plants in their natural environment and incidentally secured much good training, the value of which is attested by many who experienced it.

The period dominated by Gray's ideas was not without tendencies toward change. In the seventies there began a period of unrest in the biological sciences for which two factors were largely responsible. Huxley had begun in England to use the biological laboratory for instructional purposes. At the same time, increasing numbers of biologists were going to the great German research laboratories for training, and returning thoroughly imbued with the laboratory idea. These men took positions in colleges and influenced the teaching of botany in high schools in no small degree. Attempts were made to establish laboratory work in botany, and some success was achieved. In general, Gray's text prevented any great development of the laboratory. But in the last decade of the nineteenth century, books were written by Spalding and Bergen, which opened up the way for the permanent establishment of the laboratory in teaching botany in the high school.

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[2]W. L. Eikenberry. The Teaching of General Sciences. (Chicago, University of Chicago Press, 1922), p. 37.

II. PREVIOUS STUDIES

A. Scope

Very little has been done in the field of research on analysis of botany content in the high school course of study. In 1924 the committee of reorganization of the biological sciences appointed by the Cleveland biology teachers club, with Mr. Ellis C. Pershing as chairman, prepared, after two years of work, tentative courses of study in high school biology and high school botany.[1] This committee made no analysis of textbook content, however, in either field. The course of study was formulated out of past experience and the combined judgment of the teachers of biology in the Cleveland school system. Therefore, the only finding resulting from this study was an outline course of study for biology in the ninth year and botany in the twelfth year.

In 1926 Charles William Finley completed a Doctor's dissertation in Columbia University.[2] His problem was to determine the significant historical changes with respect to purposes governing the teaching of the biological sciences, botany, zoology, physiology, and general biology, in the secondary schools of the United States.

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[1] School Science and Mathematics, (1924) pp. 241-246

[2] C. W. Finley. Biology in Secondary Schools and the Training of Biology Teachers (New York: Columbia University Teachers College. 1926).

The method employed by the author was a careful and detailed study of the prefaces and contents of forty-five textbooks, and laboratory manuals of subject matter and of textbooks, monographs, pamphlets, and articles on the methodology of the biological sciences published during this period.

Finley's[3] findings of this study on botany were as follows:

1. "The subject as first taught (in the secondary schools of the United States) concerned itself with anatomy and classification of flowering plants." Each pupil "was required to collect, preserve, and label properly . . . a specified number of flowering plants . . ." "The botany of that early period can be characterized as a vocabulary subject," that is, the learning of numerous structural and descriptive terms. Coupled with this emphasis on anatomical structure and its attendant classification was a religious aim" to bring the pupil to a better understanding of God through a study of his works as manifested in living things . . ."

2. Botany of the last decade of the nineteenth century "might well be spoken of as the morphology of reproductive structures." "Large claim was made by the biologists of the day for the disciplinary value of the subject." "The period witnessed the appearance of numerous laboratory manuals, and laboratory work in secondary schools at its height. The lower plants,

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[3] C. W. Finley, op cit., p. 31-32.

Algae, Fungi, mosses, and ferns, received attention. Type forms were studied." "Laboratory notes and labeled drawings took the place of the hitherto required herbarium of'50 local plants.'"

3. The decade beginning with 1900 marks a transition period: "Teaching botanists of the day began to question the disciplinary value of the systematic morphological botany", in its place, plant ecology, plant physiology, and economic relations of plants came to be stressed. "Not only botany but all the sciences in secondary schools became . . . less formal and more vital," a tendency which continues to the present time.

In 1929 Amos N. Merrill[4] completed a piece of research in which he set up an objective basis for the determination of the objectives and materials for a course of study in botany for secondary schools.

The problems involved in Merrill's study were: (1) to determine the objectives and materials for a high school course in botany as determined by social needs; (2) to ascertain how nearly the materials presented in twelve widely used high school textbooks compare with the materials discovered in the social fields for organizing a high school course in botany to meet social needs as they appear from the fields of human activities investigated.

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[4]A. N. Merrill. Journal of Educational Research. (Jan. 1929. Vol. XIX), pp. 31-38.

The method of procedure was to analyze, page by page, the ordinary botanical textbooks. Notes were taken on 3 x 5 cards of the groups of plants and, when necessary, of the specific plants discussed, also of the particular activities or relations which were being considered in connection with the various plants or plant groups. A study of these cards showed that twenty-three plant groups were considered. This procedure enabled the investigator to determine the number and the nature of the discussions about plants, and plant groups in the various periodicals.

The findings of Merrill's study[5] were: (1) The writers of periodical literature devoted more than seven times more space to a consideration of the food-producing groups of plants than did the writers of textbooks. (2) . . . the textbook writers devoted over three times the space to discussions relating to lower forms of plant life than did the writers of the periodical literature examined. (3) Seven times more attention was found to be devoted to the economic phase of plant life by the writers who produce literature for general reading than by those who write the textbook materials for high school pupils. (4) A course of study in botany for general training, also the objectives to be achieved through pursuing such a course based on the foregoing data, clearly must emphasize the economic phases of plant life. In the light of this information there is need for shifting

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[5] A. N. Merrill, op. cit., p. 38.

the emphasis in plant studies in courses designated for general training, from the lower to the higher forms of plant life amd for discussing these forms in their relations to human welfare.

B. Limitations of the Study

There have been fewer textbooks written in the general field of botany at the high school level than have been written in any other branch of the biological group at this level. This study has been limited to the available textbooks in the general field of high school botany. Special books written on certain phases of botany have been omitted from the study.

The table set up for this study contains only the major divisions of botany to be offered in high school course of study. The minor divisions are omitted.

In dealing with content one finds that there is always some degree of overlapping of subject matter. In botany, for example, there is an overlapping of such phases as physiology and morphology; reproduction and evolution, and ecology and taxonomy. This is true of related science and in not a few cases to unrelated subjects. No attempt has been made to show the amount of overlapping in the various topics chosen for this study.

No effort was made to evaluate textbooks in terms of relationship of one to another, either on basis of quantity or quality of content.

In making the textbook analysis, the writer has not

considered the various state and local adopted courses of study. All these considerations fall outside the scope of this study.

The study here has been made on the basis of content by page and content by topic and is therefore limited to changes which these methods reveal.

III. DEVELOPMENT OF PROBLEM

In collecting the data for this thesis it was necessary to make a survey of the suitable available texts in the general field of botany, which was adapted to the high school pupil. Then it was next in order to arrange these texts by titles according to their chronological periods. The next step was to divide the fifteen texts into three groups of five each, beginning with the earliest five, then the second five, and finally the third group of five. The authors were listed with each text. The third step was to list the publisher. The fourth step was to list the year that each text was copyrighted. The fifth and last step was to give each text a table number, which was given in the chronological order. The number here assigned was used throughout this study when referring to texts by table. This was necessary to avoid bulkiness in the table construction.

Table I, on page 15, incorporates the above-mentioned items.

The table contains from left to right, (1) the textbook title, (2) the author, (3) the data of copyright, (4) the publishers, and (5) the book number that is used in listing the texts in table II, page 17.

TABLE I

SOURCES OF DATA USED IN THE STUDY

Title of Textbook	Author	Date of Copyright	Publishers	Number
Principles of Botany	Bergen & Davis	1906	Ginn & Co.	1
Essentials of Botany	Bessey, C. E.	1889	Henry Holt & Co.	2
Plant Studies in Elementary Botany	Coulter, J. M.	1900	D. Appleton & Co.	3
Teaching Botanist	Ganong, W. F.	1899	Macmillan Co.	4
Outlines of Botany	Leavitt, R. G.	1901	American Book Co.	5
Textbook of Botany	Allen & Gilbert	1917	D. C. Heath & Co.	6
Botany for Secondary Schools	Bailey, L. H.	1913	Macmillan Co.	7
Plant Life	Farmer, J. F.	1913	Henry Holt & Co.	8
Fundamentals of Botany	Gager, C. S.	1916	P. Blakiston's Sons and Co.	9
Plants and Man	Bower, F. O.	1925	Macmillan Co.	10
Applied Economic Botany	Cook, M. T.	1923	Lippincott Co.	11
The Wonder Book of Plant Life	Fabre, R.	1924	Lippincott Co.	12
First Course in Botany	Polls & Evans	1928	Ginn & Co.	13
General Botany	Transeau, E. N.	1925	World Book Co.	14
Textbook of General Botany	Smith, G. M.	1932	Macmillan Co.	15

Table II, on the following page, shows the distribution of the eight major topics in each text listed from Table I, page 15. The eight topics used in this table are: Introduction, Plant Structure and Physiology, Reproduction, Taxonomy, Morphology, Ecology, Evolution, and Economic Botany.

Under each of the above topics the number of pages was tabulated and the total number of pages for each text was ascertained.

This table furnished the data for finding the per cent of the total pages of each book devoted to the individual topics.

After completion of the table it became evident that certain topics were gaining in content, such as plant structure and physiology, evolution, and economic botany.

The topic "Introduction" was used to make the total number of pages correct for each book. Very little trend in introduction could be shown because of the author's individual style.

Plant structure was included with plant physiology because many of the authors includes it in that relation in their books.

The tabulations were made for each topic of each book; then the columns were added vertically and the totals were rechecked for errors.

TABLE II

THE DISTRIBUTION OF EACH TOPIC AS LISTED UNDER EACH TEXT

Textbook by Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Topics	Number of Pages Listed in Each Topic														
Introduction	3	0	5	0	0	0	0	4	0	10	0	0	8	0	20
Plant Structure and Physiology	94	129	163	48	80	199	203	82	320	120	125	292	163	232	337
Reproduction	19	10	2	4	10	15	5	42	29	0	12	25	23	39	28
Taxonomy	99	107	0	47	44	69	143	0	24	0	51	0	92	96	34
Morphology	43	33	157	43	68	50	17	45	18	0	22	39	19	0	39
Ecology	21	20	54	28	22	10	65	42	12	87	14	21	27	61	29
Evolution	0	0	0	14	2	0	0	12	35	0	0	7	4	29	67
Economic Botany	0	0	0	0	0	45	0	15	90	13	23	16	60	95	65
Totals	279	299	381	184	226	388	433	243	528	230	247	400	396	552	619

Table III, page 20, shows the distribution in per cent of the eight topics studied.

The per cent of each topic of content was computed for each of the fifteen texts. These percentages were calculated to nearest tenth of one per cent. Then the per cent columns were totaled for each book, as a check.

The per cent of "Introduction" was varied throughout, showing that it was a matter of individual style among authors rather than a significant point of content.

The per cent of content of "Plant Structure and Physiology" consistently increased from the earliest texts to the more recent ones, showing that the trend was fairly well established over this group.

But the per cent of the topic, "Reproduction" showed a slight decrease with the more recent books. This is partly due to the fact that the later writers have had a tendency to include a part of this in the topic of physiology and structure.

"Taxonomy" shows a large decrease in content, because there seems to be a tendency to get away from the more technical side of the biological sciences as well as the physical sciences in the high schools, thus motivating the study because of greater pupil interest in the subject matter, and in so doing training a larger group of children to appreciate their surroundings.

"Morphology" likewise shows a decrease in content; likely

this is due to the possibility that this phase has beem placed with physiology and structure.

"Ecology" is more or less constant in the percentage of content in the textbooks examined; however, there seemed to be a greater gain through the middle period of these texts than at either of the other periods. Ecology is a topic that is closely allied with taxonomy; since "Taxonomy" has been decreased so greatly it is plausible that the decrease in a closely related phase has had a considerable influence on its relative.

"Evolution" has constantly increased in content especially toward the latter period. The religious sentiment which has played an important part in this topic, is gradually changing with the more enlightened clergy and laity of the country.

No division of botany has made such a decided increase as has "Economic Botany". This is probably due to: (1) the tendency in our school systems today toward a more generalized curriculum, and (2) tendency toward teaching the appreciative types of botany.

TABLE III

TOPIC DISTRIBUTION IN PER CENT

Textbook by Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Topics	Per Cent of Each Topic														
Introduction	1.1	0	1.3	0	0	0	0	1.6	0	4.3	0	0	2.0	0	3.2
Plant Structure and physiology	33.7	43.1	42.8	26.1	35.4	51.2	46.9	33.7	60.6	52.2	50.6	73.2	41.2	42.0	54.4
Reproduction	6.2	3.3	.5	2.2	4.4	3.9	1.1	17.3	5.5	0	5.0	6.2	6.0	7.0	4.5
Taxonomy	38.0	36.0	0	25.5	20.4	17.8	32.2	0	4.5	0	22.6	0	23.2	17.4	5.4
Morphology	14.0	11.0	41.2	23.2	30,0	13.0	4.8	18.5	3.6	0	7.9	9.6	4.7	0	6.3
Ecology	7.0	6.6	14.2	15.0	9.7	2.6	15.0	17.3	2.3	38.0	5.6	5.2	6.9	11.0	4.8
Evolution	0	0	0	8.0	.1	0	0	5.0	6.2	0	0	1.8	1.0	5.2	10.8
Economic Botany	0	0	0	0	0	11.5	0	6.6	17.3	5.5	8.3	4.0	15.0	17.4	10.6
Totals	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.

Table IV, page 22, contains the average per cent of the number of pages of content for the first five textbooks, the second five, and the third five, for each of the topics studied. The third group of texts was compared with the first group on the basis of average per cent.

The third group showed an increase of .56 per cent over the first group on "Introduction" content, an increase of 16.1 per cent on "Plant Structure and Physiology" content and an increase of 2.42 per cent on Reproduction" content, while a decrease of 10.26 per cent was shown on the "Taxonomy" content. "Morphology" shows a decrease of 18.18 per cent of content, "Ecology" decreased 3.80 per cent, "Evolution" made a slight increase of 2.14 per cent of the content, and "Economic Botany" content increased 11.06 per cent.

These increases and decreases show some very interesting tendencies in textbook content during this period. There seems to be a strong tendency toward increasing the plant structure and physiology and economic botany content in the more recent books. There is a trend toward reducing the taxonomy, morphology, and ecology content, which looks as though the textbook writers have turned in the direction of generalization and are breaking away from technical botany for the high school student. This is in keeping with the ideas of some of the leaders in the field of curriculum-making today.

TABLE IV

TEXTBOOKS ARRANGED CHRONOLOGICALLY INTO THREE GROUPS

Textbooks	1-5	6-10	11-15	Contrast of Third Group Over First	
Topics				Decrease	Increase
Introduction	.48	1.18	1.04		.56
Plant Structure and Physiology	36.2	48.92	52.3		16.1
Reproduction	3.32	5.56	5.74		2.42
Taxonomy	23.98	10.90	13.72	10.26	
Morphology	23.88	7.98	5.70	18.18	
Ecology	10.5	15.04	6.70	3.80	
Evolution	1.62	2.24	3.76		2.14
Economic Botany	0.0	8.18	11.06		11.06

Table V, page 24, records the average per cent of topics for the entire fifteen texts as compared with the average per cent of the last five texts. The average for the last five books were taken from Table IV, on page 22, column 4.

This table shows but little difference in per cent from that of table IV, on page 22, but the tendency is the same except in the case of numerical ratio.

The last group of five textbooks reveals the following increase in content topics over the average per cent of the fifteen: "Introduction", .14; "Plant Structure and Physiology", 6.50; "Reproduction", .67; "Evolution", 1.22; "Economic Botany", 4.65; while "Taxonomy" decreased 2.48, "Morphology", 6.82, and "Ecology", 4.07.

This shows that there is a fairly consistent tendency in the particular direction pointed out above. The per cent of increase and decrease seems to increase slightly over each few years. Although there are a few interruptions, the five texts from 1917 to 1925 show a much greater decrease in "Taxonomy" than do the later five. The middle group also indicates an increase in "Ecology", while the last five show a decided decrease.

TABLE V

A COMPARISON OF TOPIC GROUPS ON THE BASIS OF AVERAGE PER CENT

Topics	Topic Average in Per Cent	Average Per Cent of Third Group	Difference Decrease	Difference Increase
Introduction	.9	1.04		.14
Plant Structure and Physiology	45.8	52.30		6.50
Reproduction	4.87	5.74		.67
Taxonomy	16.2	13.72	2.48	
Morphology	12.52	5.70	6.80	
Ecology	10.77	6.70	4.07	
Evolution	2.54	3.76		1.22
Economic Botany	6.41	11.06		4.65

TABLE VI

THE TOPICS BY NUMBER AND RANK

Topics	Average Per Cent of Topics	Topic Number	Topic Rank
Introduction	.9	1	8
Plant Structure and Physiology	45.8	2	1
Reproduction	4.87	3	6
Taxonomy	16.2	4	2
Morphology	12.52	5	3
Ecology	10.77	6	4
Evolution	2.54	7	7
Economic Botany	6.41	8	5

The above table gives each topic a rank. The rank of each of the various topics studied was ascertained by ranking the average per cent of topic content for the entire number of text-books studied.

A topic number was assigned to each topic in the order of sequence in which the topics have been listed throughout this study.

The topics in order of rank are (1) "Plant Structure and Physiology", (2) "Taxonomy", (3) "Morphology", (4) "Ecology", (5) "Economic Botany", (6) "Reproduction", (7) "Evolution", and (8) "Introduction".

While "Taxonomy", "Morphology", and "Ecology" have shown a rather decided decrease in percentage of topic content, it is still evident that these three topics remain in the upper fifty per cent of the present botanical content, and second only to plant structure and physiology in total number of pages of content.

In a period such as the present one, there should be more pupils enrolled in the science courses in the high schools of the United States, than have been in the past few years. Although the subject matter has been in many instances too technical for the greater number of these children and has, by popular opinion, steered them away from the science curriculum. This is an evolutionary trend in the secondary school program today, and, if it is met in an intelligent and gratifying manner, some of the subject matter content as well as the procedures and techniques of presenting it must be changed.

The report of the Bureau of Education for 1924[1] showed that out of the total number of students enrolled in the high schools,

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[1] U. S. Bureau of Education, Bulletin Number 7. Washington D. C. 1924, p. 6.

8.93 per cent registered in physics, 7.40 per cent in chemistry, 5.08 per cent in physiology, 3.84 per cent in botany, 1.53 per cent in zoology, 8.74 per cent in biology, and 18.27 per cent in general science.

Holmquist[2] made a study of 109 of the 240 high schools of Minnesota, ranging in size from a school of 48 pupils to one of 3,078 pupils. He reported that seventy per cent gave courses in general science, thirty per cent in general biology, twenty-three per cent in zoology, twenty-eight per cent in botany, and twenty-three per cent in physiology.

Finley surveyed and summarized several studies of science content other than botany and formulated conclusions as follows: There is a fairly well recognized science sequence in our secondary schools. In the four-year high schools, general science and general biology are predominant in the ninth and tenth grades, respectively, with the special sciences predominant in the two upper grades. In the junior-senior high school, general science and general biology are found in the junior high school, and the special sciences in the senior high schools.

The special biological subjects (botany, zoology, and physiology) are decreasing, judging from the number of schools offering them. The loss in these special biological subjects

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[2]Holmquist, A. M. The Biological Sciences in Minnesota High Schools. School Science and Mathematics. Vol. XXII, 1922 pp. 166-174.

is more than compensated by the gains in the number of students taking courses in general biology and courses in general science, of which a large part concerns biology.

Since these studies have been made, there are some other factors to consider; namely, the tendency to place general science in the eighth grade, which makes it entirely a junior high school subject; and a slightly less tendency to require general biology in the ninth grade.

Figure 1, page 32, is a graph showing the distribution of the topics as they were listed in Table V, page 24, of this thesis. The graph shows in per cent, the distribution of the topics in the order in which they were listed in Table V, rather than according to topic rank.

Figure 1 shows that the topic "Introduction" is relatively insignificant when compared to the other headings, which is to be expected since the practice of all textbook writers is usually toward a rather brief introduction. Topic two is very conspicuous because the subject matter, plant structure and physiology, lends itself very well to the developing student interest and to the teaching of comparable biology. Topic three remains at a rather low mark on the percentage line. This topic, being less expansive in content and, by nature, more technical in presentation, therefore occupies a place in the more advanced courses in the biological sciences, possibly at the college level. Topic four,

"Taxonomy" stands fairly high in quantity of content. The reason for this is one partly historical in significance. Since the time of Linnaeus, botany has been largely a study of classification. Linnaeus himself presented and taught botany strictly on the basis of plant classification. In very early times there were no definite groupings under which plants could be placed, and no orderly arrangement at all. It is then of no small consequence that when a system so complete as the one laid down by the great botanist Linnaeus appeared that students within his sphere of influences became mere students of taxonomy. This influence has been felt in no small degree in all general textbooks of botany written down to the last few decades. But as taxonomy has developed as it has been, it became very extensive and also very complicated, which made the study of botany prohibitive to many of our high school pupils all over the land. The tendency seems to be toward reducing the content of taxonomy in the botany texts at the secondary school level, although it has taken a long period to arrive at this. Botany in the future will be more interesting to a larger number of children who will participate more liberally in this study. Topic five, "Morphology", stands at a fair height on the scale. Like taxonomy, morphology is a product of tradition. When anatomy began to develop, the early experimentation in the field created a wide and profound interest. This interest naturally carried over into all the

related biological fields. The great interest in the phase of morphology developing out of anatomy has made so much progress, that morphology has become more or less technical as a high school unit of botany. Topic six, or "Ecology", has considerable representation in botany, first because it is a half-brother to taxonomy; secondly, because it is well adapted to pupil-motivation in that it deals with environmental factors which are basic in the regular routine of living, citizenship, and character building. Topic seven, "Evolution", is next to the lowest in amount of content, many authors not including it at all. This topic in the zoological field created such a furor in the early period of scientific development in this country that it became illegal to even mention evolution in the classroom. This alone has had a great influence on the more recent writers of textbooks. The topic of evolution became involved in religious controversy in this country. For many years the rank and file of the church laymen believed that to reckon with evolution was an irreligious act and therefore bad. Great effort was made through the various Christian churches, and to a large measure was ushered in by the political itinerary, to prevent its being taught in the public schools of America. Many teachers were dismissed from teaching positions because they either believed in or, in some few cases, were thought to believe in evolution. It is clear then that any factor so closely connected with a people's life as

evolution would be very slow in being placed in the public schools. But this controversy is beginning to break down as the younger church laymen come on. Slowly evolution is making its way into its place in the team of topics in the biological subjects. Possibly the study and work of the modern archeologist has done much to remove from the minds of our people the former prejudice to evolution. Topic eight, "Economic Botany", has made a very rapid gain during the last two decades. This is in part due to the fact that for many years after agronomy and horticulture developed; then plant diseases, parasitic plants, and plant breeding were considered not as parts of the content of botany at all but as parts of agriculture. A few years ago not much had been done in the way of reforestation, establishment of game preserves, park construction, and general landscaping except in a few sections of the country. Now these projects are becoming more widely distributed over the land today, so that it is necessary to train people in the technical side of botany and also the appreciative side.

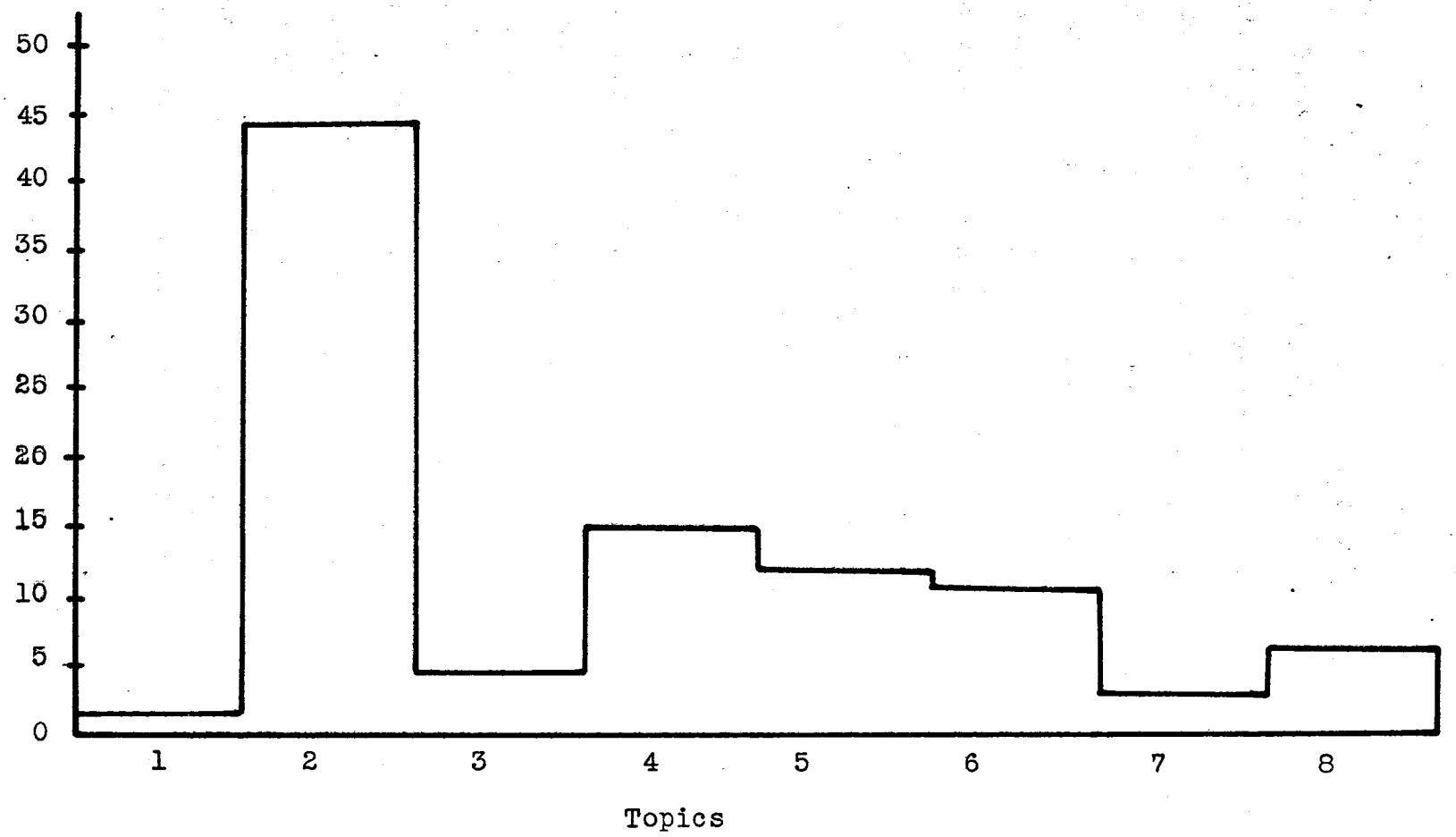

Figure 1. A distribution of the per cents of the various topics studied.

Figure 2, page 34, is a graph showing the amount of topic content in order of rank from the highest to the lowest. This is not entirely indicative of the time element to be spent on each of the respective topics. Some topics are, by the nature of the content, more condensed than others; some lend themselves to enrichment more than others; then in some cases there is some overlapping of content that may be presented as review or drill.

One must not lose sight of the fact that in the final analysis of teaching it is the child who should be taught rather than the content. Content is the subject matter used in performing the task of teaching.

The above-mentioned graph shows the per cent of content that this analysis of textbooks reveals in the order of quantity of content, almost half of which is devoted to plant structure and physiology; and in five individual cases the per cent was more than half. This means that at the present time a great deal of time should be spent in high school botany on this unit. The average per cent of topic content places topic four at 16.2 per cent, topic five at 12.52, topic six at 10.77, and topic eight at 6.41. Topic three has a per cent of 4.87; topic seven with a per cent of 2.54, and topic one has .9 per cent.

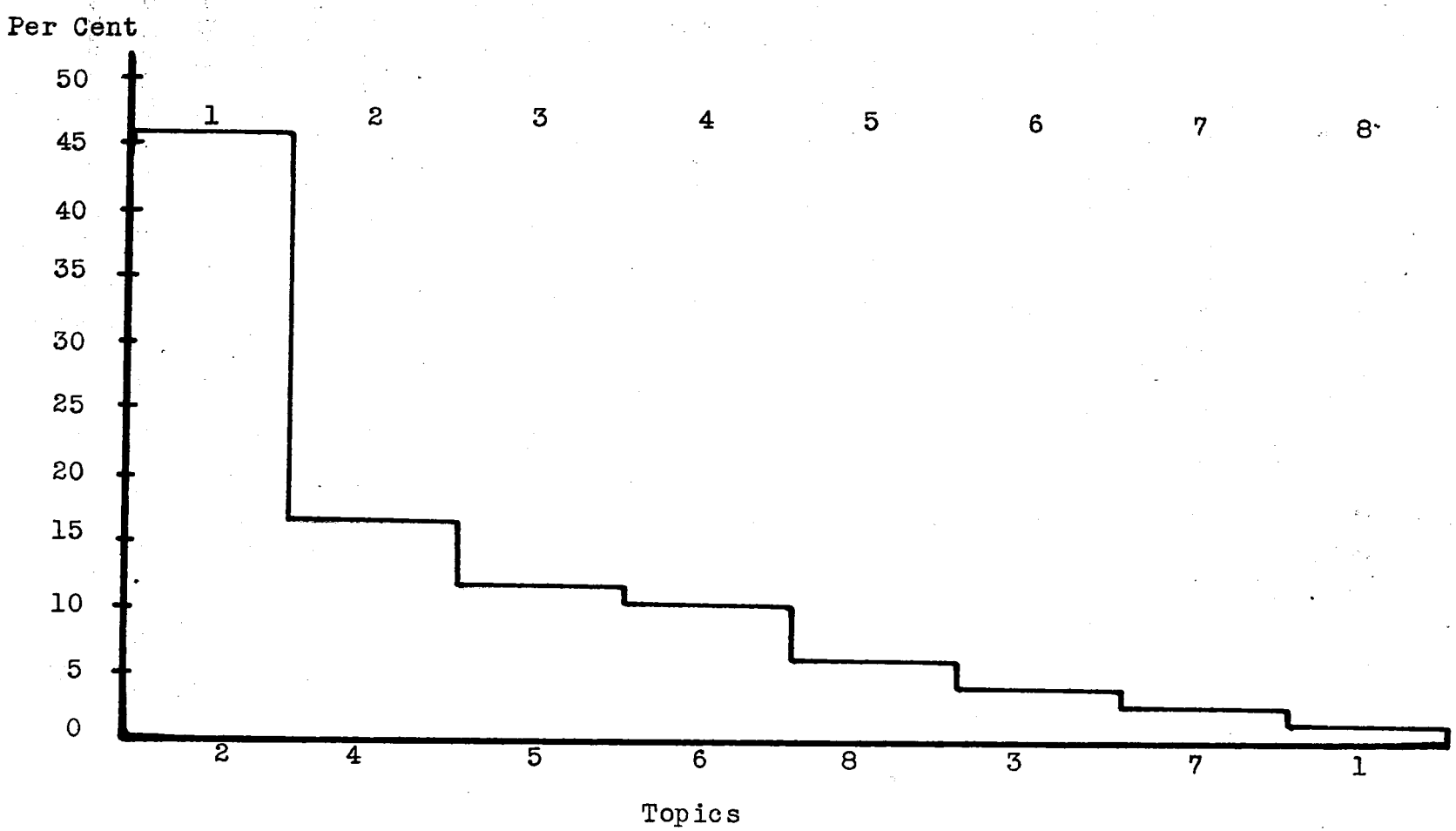

Figure 2. Topics ranked according to the per cent of content.

IV. SUMMARY AND CONCLUSIONS

A. Findings

1. Topic of Introduction. The topic of introduction shows .48 per cent of the content in the first five texts; 1.18 per cent in the second five; and 1.04 per cent in the last five. Since the average per cent is .9 per cent, an increase of .14 per cent was made by the last five over the average for the whole scope, an increase so slight that it would be insignificant. The individual style of each writer would possibly vary that much. The fact was that only six authors out of the fifteen used an introduction. It was used in this study to keep intact the actual number of pages.

2. Plant Structure and Physiology. This topic shows a very steady gain throughout the study. The first five texts contain 36.2 per cent of the total content of the group; the second five contain 48.92 per cent; and the third group contains 52.3 per cent. The average for the three groups was 45.8 per cent. This gives the third group an increase over the average of 6.50 per cent. There is probably no phase of botany so important as the one of plant structure and physiology. Certainly all the writers of general high school botany are agreed no better on any other point than that of the importance of plant structure and physiology.

3. Reproduction. The topic of reproduction is a little static in its elementary progress and therefore the per cent is low and the tendency of increase is low. The first five texts show that only 3.32 per cent of the total content of this five are contained in "Reproduction"; the second five texts contain 5.56 per cent; the third five contains 5.74 per cent. The average for the fifteen texts is 4.87 per cent; thus the last five texts show a gain of only .67 per cent over the total average.

4. Taxonomy. Taxonomy is, or rather has been, one of the outstanding divisions of botany. According to the tables, for the first five texts 23.98 per cent of the total content deals with taxonomy; the second five show 10.90 per cent; the third five show 13.72 per cent. The average for the fifteen is 15.2 per cent. The third group of texts gives a decrease of 2.46 per cent over the average for the entire group.

This reveals that the present tendency is toward less technical botany than in the earlier period. Classification is highly technical in that it depends upon rote memory to a large extent. The number of plants is so great that it really would require a great deal of memory. Then it might be said that the only person who really needs to know taxonomy is a taxonomist. The average pupil needs only to know the general aspects of taxonomy, such as the four plyla and some of the most common families of plants together with the common names.

5. Morphology. This is the second division of botany which is tending to decrease. The table of calculations places the per cent of content of morphology at 23.88 per cent for the first five texts; 7.98 per cent for the second five texts; and 5.70 per cent for the third five. The average for the whole group is 12.52 per cent. The third group of five texts made a decrease of 6.82per cent over the average for the entire group.

The recent decrease is in part due to the fact that a great deal of what has been included under the study of morphology in the past has become incopporated in the subject of plant structure and physiology.

6. Ecology. Ecology is the third topic studied to fall on the road of decreases. The first five texts reveal that 10.50 per cent of their content was made up of ecology and the second five show 15.04 per cent. This middle five discloses a per cent of 6.70 the average for the group being 10.77 per cent. The third group makes a 4.07 per cent decrease over the average for the entire group.

"Taxonomy", decreasing in a considerable amount and being closely related to "Ecology", caused a small decrease in "Ecology", "Plant Structure and Physiology" and "Economic Botany" being the divisions that absorbed this disease.

7. Evolution. "Evolution" is the most bitterly contested topic of the list. The first five texts contained 1.62 per cent of their content in evolution; the second five 2.24 per cent; the third five 3.76 per cent, the average for the fifteen texts being 2.54 per cent. The third or last five show an increase of 1.22 per cent over the average for the entire group. This shows that the evolution content is gaining very slowly, if at all. Only eight of the group of fifteen texts contain evolution content at all. Therefore this per cent which is very small is only representative of about one half of the texts analyzed. There is still a large amount of skepticism about writing and teaching the topic of evolution.

8. Economic Botany. "Economic Botany" has made the second largest gain in topic content in the subject of botany studied in this analysis. The first five texts showed no content in the unit of economic botany at all; the second five showed 8.18 per cent of the content in this topic; the third five showed 11.06 per cent, which makes an average for the fifteen texts showed an increase of 4.65 per cent over the average of the whole group. This increase is due to the tendency of society to appreciate and beautify their surroundings, to begin and make progress along conservation lines, to supply new and better food, to travel in the different parts of the country, and to increase the pathogenic element of agriculture. It is said that rust

alone in Indiana destroys enough wheat annually to send over eight hundred boys and girls to college for four years at five hundred dollars each, per year. Many other such examples could be cited. So this seems to be a very progressive topic in the high school of today.

9. Number of Textbooks. The number of textbooks in the general field of botany at the high school level is limited. Botany is a subject which lends well to special phases. There are many books written on special fields in botany. The scope of topic content is so large that if each is included the book would become somewhat bulky.

10. Number Pupils Enrolled. There are fewer people in the high schools of America studying botany than are studying any other subject except zoology, 3.84 per cent being engaged in the study of botany and 1.53 per cent being engaged in the study of zoology, according to the bureau of education in 1924.

11. Botany Course of Study. Very little work in the field of research has been done on the botany course of study or the content analysis of botany.

12. Present-Day Writers. The writers of botany texts at the high school level are pretty well in harmony with the trends in modern education. They seem to be more democratic than formerly in the division of topics; thus the subject of botany

may become one of the prominent sciences in the senior high school.

B. Suggestions

Since only 3.84 per cent of all the high school pupils of the high schools of America study botany, it is likely that the course of study is not worked out as well as it should be. It would be well to interest some of our high school teachers of botany in the plan of constructing a new course of study in high school botany, with the pupil instead of the subject matter of botany as the central unit.

A suitable course of study might not be worked out in a year's time or even two years. It would take several years to arrive at something that would be ideal. The time is coming when the high school curriculum is going to be enriched not only in the extra curriculum activities, but also in the subject matter content. We are living in a scientific age amd world, but not so much science has been taught in the past. Our schools have been ones of classical nature in most part, holding to the classical subjects. The higher institutions of learning have been largely responsible for this almost unbelievable evil, in that they all required the classical subjects for entrance. Luckily they are slowly breaking down this barrier so that the high school administrator will soon have not only the chance, but

the task of building for the secondary school a new curriculum. This curriculum will be greatly influenced by the scientific field as well as the vocational field. Recently, it is doubted whether it is wise to administer eleven years of English, and ten years of mathematics to pupils in the first twelve grades of school, and not more than two years of science. There is also the need for some new textbooks to be written in the field of botany, together with some good workbooks constructed on the supervision-of-study plan, so the student can do his work according to a well-organized plan.

Then the high school curriculum should be organized with a proper guidance program that would help direct the pupils who are working toward a technical course in college or a professional course that is scientific to enter the science courses in both physical and biological sciences in the high school. Not only should scientifically inclined and technically inclined students be ushered in upon this new curriculum, but all pupils should have certain scientific knowledge in order to appreciate the world around him. There has been too little organization of this kind put into practice in our high schools.

Botany is one of the oldest of the biological sciences and has lagged behind all the others in the frequency of participation in the high schools of the United States. The student

enrollment in this study has been so small that not many departments have been built up. It has merely been offered when the pupils would demand it or when some one in the system held a license in it and not in some other biological sciences. This status caused the teacher to be more or less disinterested in building up the course of study. Oftentimes in the smaller systems it was the principal who taught this subject, knowing that probably within a year's time another teacher would be brought into the school who would have a license in biology and relieve him of all the worries of the science program.

Botany is the foundation of all agronomy, gardening, horticulture, and, to a large degree, landscaping. It therefore seems that with a basis so far reaching as this, botany should have a more important place in the course of study in the high school.

The economic conditions of our country has had a great deal to do with the status of the present high school curriculum. The number of teachers in many of the high schools has been reduced, thus making it necessary to decrease the number of subjects offered. If our economic conditions become better, or even school financing is better worked out, our road to success in better curriculum construction will be quicker and more highly developed.

The textbooks should be more generalized and adapted to the student who is not particularly interested in science, but who

may be a superior student and should know something of the plant world in general around him. Then there is the pupil who has only an ordinary degree of achievement, one who is not capable of keeping up with the former group. This pupil also needs to know some things in general about his environment in the plant kingdom. There is another class of students who are already interested in the plant and need further stimulation. So often in the past this group of students has been told: "You can't get this knowledge here; you will have to go to the university or college to make this study." In many cases these students are never permitted to attend the higher institutions of learning. How much better it would have been could we have offered this sincere and well established interest a chance to function, and perchance a Gregor Mendel or a Luther Burbank would have been produced. The thought arises here that we are literally robbing the world of some very fine services that might be rendered if these keen minds had a chance to function before the interest was lost or before the individual became too old to reach the highest capacities.

It is well at this point to mention administrators in connection with this phase of work. The administrators in the future must be properly informed of this need in the modifying of the curriculum, or the teachers are going to lack support in their efforts to humanize the course of study in the high

schools of the country.

The plea that has been made here for botany is one that should be made for all sciences in the physical as well as the biological fields.

It must be further understood that the argument presented in this thesis is not one of making the subject matter easier, but rather one of making it more useful and adaptable to the child and the progress of civilization enhanced.

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