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The administration of a course in general science.

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THE ADMINISTRATION OF A COURSE IN GENERAL SCIENCE

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THE ADMINISTRATION OF A COURSE IN GENERAL SCIENCE

The name "general science" is apt to be misleading. The term "general" is apt to deceive people as to the content of the subject. Webster's Collegiate Dictionary defines the word "general" as follows: 1. Of or pertaining to the whole; not local, as a general election; also taken as a whole. 2. Pertaining to or affecting each and all of a class or kind;not particular.3.Not limited to a precise import or application;not specific or in detail,as a general plan.4.Of or pertaining to what is typical or generic,not concrete.5.Common to many;prevalent, extensive,though not universal,as a general rule.6.Of or pertaining to a heterogeneous or miscellaneous group;broad catholic,not special or specialized, as a general store.7.Not precise or definite.8.Chief superior,as attorney general,etc.

It is thus seen that general science is hampered by its name,"General Science"sounds like superficial science and superficial science sounds like"inaccurate" science which sounds like nonsense. If the study had been launched under some such name as synthetic science,it would have been less misunderstood by outsiders and it would have impressed on its practitioners the idea that it differs from the several sciences not only in grade, methods, and arrangement but also and more significantly in point of view.General Science is not a crazy quilt made up of patches torn from the various sciences; on the contrary the various sciences consist of patches torn from the seamless robe of truth which is the object of general science to present in its pristime unity, its natural integrity."(1)

Science is defined "as accumulated and accepted knowledge systematized and formulated with reference to the discovery of general truths or the operation of general laws; classified knowledge."(2) It may also be defined as "a body of systematically arranged knowledge gathered from careful and purposeful observation."(3) General Science is the study of the scientific facts and laws which relate to our environment. Thus it is seen that general science is a science because it takes this knowledge gathered from careful and purposeful observation and applies it to our environment; it classifies scientific knowledge into the various aspects of our environment.

Because of its gradual development the history of general science is difficult to trace. "Huxley has been named as the originator of the teaching methods used in general science to-day. He gave a series of lectures describing nature to the children of London in 1869. These lectures were not technical but were merely given to be entertaining and informative. Tyndall and Faraday also were said to have used these same teaching methods in their writings and lectures."(4)

The first appearance of general science in modern

(1) Edwin W. Slosson, "The Philosophy of General Science," School, Science, and Mathematics, (January 1925) pp.9-20.
(2) Webster's Collegiate Dictionary, 1930 Edition, G. and C. Merriam Company.
(3) Richard W. Sharpe, "General Science", Oxford Book Company, 1931 Edition, p.1.
(4) George Mounce, "Some Tangible Results from a course in General Science," School, Science, and Mathematics, (October 1920) pp.632-36

times seems to have been in the Lake High School(now the Tilden High School) Chicago,Illinois.Elementary physics, chemistry,and biology were organized into a course in science for the first year high school students.It was substituted for the course in physical geography and physiology then prevailing.One of the organizers of this course was John C.Hessler,author of a general science textbook which is used in many schools today.(1)

"In Springfield,Massachusetts,in 1904,Mr Balliet, superintendent of schools and Mr.Orr,principal of the Central High school,combined a course of biological and physical science in order to make science attractive to the pupils. This new course was then taught by Mr.Russell and Mr.Kelly, instructors in the high school.It drew its material as far as possible from local environment and those things within the interest and experience of the child."(2)

"Causes that led to the introduction of general science were:

1.The tremendous growth of the high school and the cosmopolitan character of the school population which made of the high school a second school for the education of the masses.

2.The advances in pure and applied science which demanded on the part of the future citizen an understanding of an adjustment to an environment modified by man's

(1) Personal letter from John C.Hessler,dated December 12,1933.
(2) George D.Von Hofe,"History of the General Science Movement," General Science Quarterly,(May,1917) pp.200-206.

scientific discoveries and inventions.

3. The inadequacy of a program of science to help one to live intelligently in a modern environment.

4. The formal abstract character of the special sciences and the consequent relative decrease fulfilling the possibilities of science study in a complete educational program for life in a scientific age.

5. The low enrollment of pupils in science courses offered during the first and second years which resulted in a majority of our youth not receiving instruction in science before leaving school.

6. The lack of a sequence in science courses in the secondary school that would provide orientation and educational guidance for pupils in the field of science.

7. The tremendous gap between the nature study of the elementary school and the special sciences of the high school and the resulting lack of provision for a transitional course between the two widely different types of science courses.

8. The changing aims of secondary education."(1)

"In 1905, L. D. Higgins wrote a book entitled "First Science Book" which was published by Ginn and Company. It was an introduction to the scientific study of common phenomena and took the form of an elementary physics."(2)

(1) C. J. Pieper "Science in the Seventh, Eighth, and Ninth Grades," National Society for the Study of Education 31st year book, pp. 193-221.

(2) S. F. Frolio, "The Improvement of the Teaching of General Science in the Junior High School", Master's Thesis, 1931, B. U. pp. 1-5.

For the next few years the various branches of science were included in the content of general science courses. "Among these earlier types of general science courses we find the course which was a combination of the elementary parts of the specialized sciences. Another type of course found its organization and selection of content in line with the topics of a single special science-physiography, for example-and extended the content here and there into the field of other special sciences or into the environmental topics. A third type was the course based upon the traditional idea that the first part must be in the nature of basic facts, definitions, and so called fundamental concepts, and that the second part can then proceed to a consideration of topics bearing direct significance to daily life."(1)

With these various branches under one head each course became adapted more and more to local needs and a study of the environment. "Most of the textbooks at this time were little more than a series of introductions to the specialized sciences."(2)"

"However, by 1915 general science had made considerable headway in the school."(2) "In 1922, 18.27 per cent of the students in the public schools in this country were enrolled in general science courses."(3)

(1) C. J. Pieper, "Science in the Seventh, Eighth, and Ninth Grades", National Society for the Study of Education, 31st Yearbook, pp. 193-221.
(2) A. A. Douglas, "Secondary Education", Houghton Mifflin Company, 1927 Edition, pp. 259-260
(3) U. S. Bureau of Education, Department of Interior, Bulletin number 7, 1924 pp. 46-47.

Today a majority of the more recent books in general science have broken away from the older methods and some of them quite successfully draw from the various scientific fields the material needed for the problems that they present."(1)

"General Science was naturally introduced first into the ninth grade where the experimentation has been largely carried on. It is beginning to find its way into the curriculum of the seventh, and eighth years. It will and should become a required major subject in the junior high school program of studies throughout the three years."(2)

(1) A. A. Douglas, "Secondary Education," Houghton Mifflin Company, 1927 Edition, pp. 259-260.

(2) James M. Glass, "Practices in the Junior High School and Grades Five and Six", Supplementary Education, Monograph number 25, University of Chicago Press, (November 1924) p. 81.

Status of General Science

What is the status of general science in the schools today? There seem to be no recent figures as to the number of students enrolled in general science courses in the high schools in the United States. However, the Bureau of Education Bulletin 1924 number 7. pp. 46-47 mentions, "In 1922, 18.27 [illegible] per cent of the pupils were enrolled in general science in comparison with 8.9 per cent enrolled in physics, 7.4 per cent enrolled in chemistry, and 8.7 per cent enrolled in biology."(1)

In the same bulletin the following chart was published in respect to Massachusetts:

Size of school	27-500	500-1,000	1,000-1500	1500-2,000
General Science	13%	13%	6%	11%
Biology	14%	11%	9%	14%
Physics	4%	4%	10%	7%
Chemistry	14%	12%	12%	12%

Thus, from the point of view of enrollment in the sciences in 1922, general science was among the leaders both in Massachusetts and in the entire nation.

"General Courses are fast taking the place of the specialized courses of the old seventh, eighth, and ninth grades. General Science has almost entirely supplanted physiography. General subjects represent little more than the application of the educational principles of relative values, interest, and arrangement of subject matter in terms of the learner. Perhaps the greatest advance in the applications of

(1) Bureau of Education, Bulletin number 7, 1924, pp. 46-47.

these principles has been in general science.The popularity of this subject is evidenced by the fact that it is today the most important science course from the standpoint of student enrollment in the secondary school.It has for its field problems that which concern the average person and which are solved through the applications of scientific principles. It does not matter whether these principles are from the realm of physics,chemistry,or biology;they are used as they are needed."(1)

J.Harvey Rodgers(2)states,"In questionaires sent to the junior high schools in every state one hundred and one answers were returned.It was found that about one half required general science in the eighth grade.General Science courses appear most frequently in the practical arts curricula. However,even as yet general science is far from occupying the place that it should in the junior high school."(2)

"In Texas there are more students enrolled in the general science classes today than in any of the other sciences, because general science is meeting the demdnd for an elementary science which will serve as a prerequisite course for more advanced science.

Two courses making up almost all the offerings in science in the junior high school are physiology and general

(1) A.A.Douglas,"Secondary Education," Houghton Mifflin Company, 1927 Edition,pp.259-260.
(2) J.Harvey Rodgers,"Curricula and School Programs,"School Review,(March,1921) pp.198-205

science. While each of these has come currently in all grades of the three year junior high unit, the former is more often found in the seventh grade and the latter in the eighth and ninth grades. In the junior high schools including only two grades, general science appears to be a poor competitor of physiology for a place in the seventh grade but fares somewhat better in the eighth grade. Here it becomes the course predominantly given. In three year junior high schools which operate on the principle of combining required with elective subjects in the program, general science gains in ascendency from grade to grade. In such programs these two courses are occasionally listed with the variables in the ninth grade. In three year schools operating differentiated curricula the courses are almost matched in frequency in the prescribed work of all curricula in the seventh grade, the shift being to general science in the eighth and ninth grades with the latter course often among the electives in the ninth grade, somewhat more often in the academic than in the commercial and practical arts curricula. It is uncommon for other courses in science such as physiography or biology to be given either as prescribed or elective courses."(1)

John C. Hanna(2) expresses the place of general science in the high school in the following five points:

1. General Science has a legitimate place in the school.

(1) Leonard V. Koos, "The Junior High School," Ginn and Company, 1927 Edition, pp. 252-253.

(2) John C. Hanna, "The Place of General Science in the High School," School, Science, and Mathematics (June, 1920) pp. 516-526.

won after long experimentation.

2. It should be offered to all students.

3. It should be a one year course.

4. It should be organized with reference to the pupil's maturity.

5. It should precede special sciences."(1)

According to the consensus of opinions there are as many pupils studying general science today as there are any of the other sciences. The number of pupils choosing general science is increasing. General Science is supplanting mony of the specialized courses, and in many schools it is a required subject. Courses are now arranged so that general science precedes the special sciences, as it meets the demand for an elementary science which will serve as a prerequisite course for the more advanced science, and it can be organized with reference to the pupil's maturity.

(1) John C. Hanna, "The Place of General Science in the High School", School, Science, and Mathematics, (June, 1920) pp. 516-526.

The problem of this thesis is the administration of a course in general science. Questions to be considered are:

1. What should be the thoughts of an administrator in respect to general science.
2. How should it be organized?
3. What should be its content?
4. Around what aims and objectives should general science be organized?
5. Do the objectives apply to the community in which the subject is taught?
6. How should the subject be taught?
7. What laboratory procedure should be followed?

The method with which I shall attempt to solve this problem will be that of examining the educational periodicals, textbooks, courses of study, and state and federal documents, to find out the present day practice in general science. To a large extent I shall consider this material as a norm in accepting or rejecting various educational procedures in the administration of general science. However, present day tendencies, which educational literature seems about to discard, will be rejected for new tendencies around which to adapt the general science course.

Methods of Preparing Courses of Study

What are some of the prevalent and accepted methods of preparing courses of study?Wilbur L.Beauchamp in an investigation of the teaching of science in the secondary schools entitled "Instruction in Science" mentions the current methods of preparing courses.

This investigation is based upon an analysis of fifty-eight courses in general science,forty-five courses in biology, twenty-seven courses in physics,and thirty courses in chemistry.The courses which had been revised since 1925 were obtained from schools by the office of Education,United States Department of Interior.Some courses were secured from the divisions of research of the National Educational Association. Twenty-six states are represented by one or more courses of study.Visits were also made to schools in fourteen cities in various parts of the United States.Fifty-five classes were visited.The purpose of the classroom visiting was two-fold; first,to discover the extent to which the courses of study actually functioned,in dictating the subject matter presented and the technique of instruction employed;and second, to discover promising innovations in classroom technique.Most of the visits were made to cities in which revised course outlines had been prepared.

"In studying the preparation of courses of study it was found that the majority of courses in general science were formulated by committees representing each of the different fields of science;that is,the courses in general science were made by teachers of general science, courses in biology were made by teachers of biology, and so on. These committees of teachers operated under a variety of conditions, which were reflected in the course of study produced.

Four general types of situations are described in this report: 1. Committees operating under a director of curriculum. 2. Committees operating under the direction of outside talent, 3. Committees operating under a supervisor of science, 4. Committees operating without supervision.

Departments of curriculum assisted in the construction of courses of study from other school systems, science textbooks, and professional textbooks, on the teaching of science. Sometimes they formulated general aims, principles of organization, and a general scheme for the presentation of the materials in a printed course of study.

Committees operating under a supervisor of science. In one system the course of study was formulated entirely by the supervisor and his assistant. They first had set up certain principles of organization and criteria for the selection of the content. The result was a unified series of courses in the different fields. The courses were placed in the hands of the teachers who were asked to suggest changes for their improvement. The investigator believes that the majority of high school teachers would profit by more contact with the science supervisor.

Committees operating under outside talent. Experts from outside left their impress on courses of study. Some have been specialists in the curriculum, and in other cases they have been specialists in science education. The experts contributed to the development of the courses of study in such a way as to produce in the courses of the respective cities a uniformity of viewpoint and organization which is notably lacking in courses prepared without supervision.

Committees operating without supervision. In some school systems the courses of study is prepared by committees appointed for each special subject. The whole discussion of these(typical) committees was based upon personal opinions, likes, dislikes, and prejudices of the various members of the committees. After several meetings the committee, through the process of compromise, arrived at a series of topics which were duly printed and distributed to the other teachers in the system. No specific objectives of the course were decided upon. No principles of organization nor cirteria for the selection of subject matter were formulated.

Another common type of committee procedure is to meet and decide upon the topics or units which are to be included. Each teacher is then assigned to develop a particular unit. Many courses of study disclose evidence of this type of procedure by an entire lack of uniformity in the organization of the different units. One unit will present a statement outline of the important ideas, another a topical outline, and another a series of problems. Analysis of the units reveals that the individual teachers must have had entirely different conceptions of the nature of the learning process. One unit may be focused upon the accumulation by pupils of details relating to the topic under discussion. Another unit may consist of problems to be solved in which the details are used functionally to supply data for their solution. Still another unit may consist of a "hit or miss" collection of projects with apparently no other idea than "whole hearted purposeful activity" on the part of the pupils; and there may be one or more units in which the important generalizations of science and their applications in life situations are stressed."(1)

Francis D. Curtis (2) mentions, "The curriculum of science as well as the materials for the courses that make up the curriculum must be determined on one of two bases: 1. Best opinion regarding what sequence of courses should make up these questions, and 2. A combination of opinion and true results of research."(2)

A. A. Douglas (3) mentions, "The committee method of preparing a curriculum is as yet the most common method of procedure. However, similiar to the committee procedure and classifiable as methods of securing collective opinion in selecting and evaluating subject matter are the following.

(1) Wilbur L. Beauchamp, "Instruction in Science", Bulletin 1932 number 7, monograph 22. The Office of Education, United States Department of the Interior pp. 1-8
(2) Francis D. Curtis, "Curriculum Development in the Teaching of Science," National Society for the Study of Education, 31st year book pp. 121-130.
(3) A. A. Douglas, "Secondary Education," Houghton Mifflin Company, 1927 Edition, pp. 365-367.

1.A number of judges are secured who rate the worth of a series of topics.The judges are selected because of their mastery in a field.The topics are arranged sometimes by one person,sometimes by a committee.

2.Textbooks are compared to determine the stress placed upon the various aspects of a subject of instruction.Importance is judged in part by the presence or absence of treatment in some or all of the textbooks and by the amount of space given the topic in question.

3.Courses of study are compared in a manner simillar to that used in an examination of textbooks."(1)

Summarizing the various opinions as to the methods of preparing courses of study,we see that the majority of courses of study were formulated by committees of teachers operating under a variety of conditions.Four general types of committees cooperated;namely:committees operating under a director of curriculums,committees operating under a supervisor of science,committees operating under the direction of outside talent,and committees operating without any supervision.The consensus of opinion seems to be that the committee method of procedure is superior to that of having an individual prepare the curriculum.The thought behind these opinions seems to be that we should abide by the opinions of the experts in the field when preparing a curriculum. The question then arises as to who the experts are that

(1) A.A.Douglas,"Secondary Education",Houghton Mifflin Company,1927 Edition,pp.365-367.

should be chosen, the teachers, supervisors, administrators, or curriculum directors.

Probably a good method of preparing a curriculum would be to have a committee of teachers operating under a supervisor of science perform this task. However, it would differ according to local conditions, which would be dependent upon the talent of the committee and the supervisor under whom the committee would work.

General Objectives of Science Teaching

A problem attracting the attention of curriculum directors, textbook authors, and teacher today is how the objectives of general science may be determined. Let us examine some of the opinions of authorities as to what constitues the objectives of general science and science in general.

Considering the general aims of science teaching, it is mentioned in bulletin number 26, 1920, United States Department of Education, that six of the seven "Cardinal Principles of Education" are used as aims in science teaching.

"1. Health-It is the duty of the secondary school to provide instruction in the control and elimination of disease, and in public health for all pupils.

2. Worthy home membership-Science touches the efficiency of the home and of life within the home at every angle. General Science and the other sciences all have definite services to render toward the proper organization, use, and support of home life.

3. Vocation-Science instruction should contribute to both vocational guidance and to a broad preparation for vocation.

4. Citizenship-The members of a democratic society need far greater appreciation of the part which scientifically trained men and woman should perform in advancing the welfare of society. Science teaching should therefore be especially valuable in the field of citizenship because of the increased respect which the citizen should obtain for the expert and should increase his ability to select experts wisely for positions requiring expert knowledge.

5. Use of leisure time-Science opens the door to many useful and pleasurable avocations.

6.Ethical character-Science study should assist in the development of ethical character by establishing a more adequate conception of truth and a confidence in the laws of cause and effect.Science along with other studies that exalt truth and establish laws should help develop sane and sound methods of thinking upon the problems of life."(1)

Douglas states,(2)"More than sixty-five years ago Herbert Spencer showed that the schools were controlled in their instruction not by the needs of the pupils nor by the activities in which they would engage as adults but by convention and tradition.He proceeded to show that education for complete living can take place only when one is aware of the leading kinds of activity which constitute human life.

Comparing the aims of Spencer with those of the Commission on the Reorganization of Secondary Education,it is found that they coincide to a remarkable degree.Five of Spencer's objectives are almost identical with the divisions found in the Commission's analysis.He place mastery of the processes of reading,writing,and arithmetic under education for vocation.The Commission would not deny that they contribute to that objective but deem them equally important

(1)"Reorganization of Science in the Secondary Schools", Bulletin number 26,1920 United States Department of Education.pp.12-15

(2)A.A.Douglas,"Secondary Education", Houghton Mifflin Company,1927 Edition,pp.326-330.

in other lines of activity. By making them an objective in secondary education, they will be insured more time and attention in the school program of studies. Spencer leaves out the ethical character but he describes the final goal of education as "complete living"; and it would be suprising if he had any objection to ethical character as a goal in education. He seems to favor improvement through methods of training and discipline, and he expected his recommended education for parenthood to be the most important means of achieving moral education.

The difference in stress placed upon education for worthy use of leisure time in the two analyses deserves comment. Spencer believed that accomplishment in the fine arts, those things which we say constitute the efflorescence of civilization, should be wholly subordinate to that knowledge and discipline in which civilization rests. They should occupy the leisure part of life. This view has changed. The greater amount of leisure time which Spencer predicted and a better understanding of the important part played by leisure time activities in producing high moral and ethical character and in contributing toward complete living have led to greater emphasis upon training in worthy use of leisure time."[1]

Analyzing the objectives advanced by Bobbitt[2] we find

(1) A. A. Douglas, "Secondary Education", Houghton Mifflin Company, 1927 Edition, pp. 326-330.
(2) J. F. Bobbitt, "How to Make a Curriculum", Houghton Mifflin Company, 1924 Edition, pp. 8-9

that seven of his objectives mention worthy use of leisure time, seven mention health, six mention good citizenship, two mention vocation, and three mention worthy home membership. One of his objectives is indefinite but seems to deal with health and good citizenship.

Pieper and Beauchamp[1] advance four objectives. The first, deals with good citizenship, health, and worthy home membership; the second, with vocational education, worthy home membership and health; the third, with worthy home membership and citizenship; and the fourth with vocational education and worthy use of leisure time.

The objectives of Douglas are good citizenship and worthy home membership.[2]

The objectives of Bergen[3] seem to be abstract. The first objective, that of "habits of scientific thinking," when brought to an application might deal with health, worthy home membership, citizenship, vocation, and worthy use of leisure time. The remaining objectives also, if carried out to an application, would seem to agree with the principles mentioned by the Committee for the Reorganization of Secondary Education.

An examination of the objectives of Jackson[4] reveals some of the principles advanced by the Committee for the

(1) C.J. Pieper and W.L. Beauchamp, Teacher's Guid Book, Scott, Foresman and Company, Introduction.
(2) A.A. Douglas, "The Secondary School," Houghton Mifflin Company, 1927 Edition, pp. 396-397.
(3) L.M. Bergen and Others, "Objectives of Science Teaching", School, Science, and Mathematics, (May, 1931) pp. 550-559.

Reorganization of Secondary Education. The remainder of his objectives may be considered as those of Bergen not being carried out to their applications, which might cause them to be in agreement with the principles advanced by the Committee.

Cox[1] claims that these objectives are to be found in the interests and problems of life. This is in firm agreement with the principles of the Committee, as their principles are merely built around this idea mentioned by Cox. The principles of the Committee are in reality an application of the thought, how can science be applied to the interests and problems of life.

Thus, all of the general objectives of education and the general objectives of science education mentioned by the above authorities are simply extensions of the principles advanced by the Committee for the Reorganization of Secondary Education, or else they are the same principles expressed in different words and phrases.

(4) J. W. Jackson, quoted by Elliot R. Downing, "The Aims of Junior High School Teaching", Dept. of Supt. Fifth Yrbk. p. 149.
(1) Philip L. Cox, "The Junior High School and its Curriculum", Charles Scribner's and Sons, pp. 325-326. 1929 Edition.

Objectives of General Science

The objectives of general science might be considered as the specific objectives of science education in comparison with the general objectives of science education. We might consider as the most generally accepted objectives of general science today those of Beauchamp, the formation of whose report was described on page twelve.

From an analysis of fifty-one courses of study in general science he obtains a great number of objectives, the first twenty-seven of which are listed below in the order of their frequency.(1)

Type of Objective	Frequency of mention
1. To develop the ability to think scientifically.	44
2. To acquire knowledge that will produce a better understanding of environment.	40
3. To promote good health.	25
4. To study the contribution of science to mankind.	20
5. To develop power of observation.	19
6. To train for citizenship.	19
7. To acquire information about science.	18
8. To acquire ideals or habits of accuracy, persistence, honesty, self control, truth, etc.	16
9. To acquire wholesome interest which may be used to enjoy spare time.	14
10. To develop worthy use of leisure time.	14
11. To inculcate worthy home membership.	13
12. To foster the right choice of vocation.	12

(1) (His chart was not so arranged)

13.	To develop the ability to form independent judgements.	12
14.	To be openminded.	12
15.	To develop an appreciation of nature.	12
16.	To have a spirit of inquiry.	11
17.	To develop ethical character.	11
18.	To develop the power of interpretation.	10
19.	To acquire an interest in taking more science.	10
20.	To acquire an interest in nature.	10
21.	To acquire an appetite for scientific reading.	9
22.	To serve as a basis for the selection of a vocation.	9
23.	To give the pupil a view of the field of science so that he may explore his interests, capacities, and abilities.	9
24.	To serve as a basis for the selection of further courses in science.	8
25.	To appreciate the great men of science.	8
26.	To acquire an appetite for investigations in science.	8
27.	To appreciate the contributions of scientific method.	7 (1)

In addition to the above objectives of Beauchamp the opinions of twelve writers of textbooks, educational

(1) Wilbur L. Beauchamp, "Instruction in Science", Bulletin 1932 number 7, monograph number 22, United States Office of Education, Department of Interior, pp. 11-12.

authorities and teachers were obtained. Some of these thirteen opinions are in reality a group of opinions welded together by an author, who then injects his own opinion. In this case we may then consider them thirteen opinions some of which are sets of opinions.(1)-(12)(Beauchamp on previous page)

A list of these opinions in the order of their frequency of mention appears on the next page. Opinions which are the same except that they might be expressed in different words or phrases of course are tabulated together.

(1) Philipine Crecelius, "A Report on the Objectives of General Science Teaching", School, Science, and Mathematics, (April 1923) pp. 313-319.

(2) John J. Birch "The Aims of General Science", School Executives, (July, 1929) pp. 511-512.

(3) Henry Harap and Ellis Persing, "The Present Objectives in General Science", Science Education, (March, 1930) pp. 477-497.

(4) Erma B. McCaffrey, "The Laboratory-Problem-Project Method of Teaching General Science", School, Science, and Mathematics, (December, 1926 pp. 966-973.

(5) Clayton M. Howe, "What Eighty Teachers Think as to the Aims and Subjectt Matter of General Science", General Science Quarterly, (May, 1918). pp. 445-458.

(6) R.K. Watkins, "The Technique and Value of General Science", General Science Quarterly, (May, 1923) pp. 235-256.

(7) R.K. Watkins, "Bibliography of Project Teaching in General Science", General Science Quarterly, (March, 1924) pp. 522-29.

(8) Wallace H. Kiang, "The Derivation and Development of Criteria in General Science", quoted by W.R. Leker, in "The Articulation of General Science with the Special Sciences", School, Science, and Mathematics (October, 1926) pp. 724-732.

(9) C.O. Davis, "Junior High School Education", World Book Company, 1926 Edition, pp. 223-226.

(10) W.W. Theisen, "How to Accomplish Our Aims in General Science" School, Science, and Mathematics (October, 1926) pp. 733-45.

(11) New York State Syllabus in General Science.

(12) Edward E. Cureton, "Junior High School Science," School Review, (December, 1927) pp. 767-775.

Objective	Frequency of mention.
1. To acquire knowledge which will produce a better understanding of our environment.	10
2. To develop the ability to think scientifically.	8
3. To serve as a basis for the selection of a vocation.	7
4. To serve as a basis for the selection of further courses in science.	6
5. To acquire knowledge to increase the general culture of the individual.	6
6. To solve problems.	6
7. To acquire information about science.	4
8. To acwuire knowledge of health.	4
9. To train for citizenship.	4
10. To develop worthy use of leisure time.	4
11. To give the pupil a view of the field of science so that he may explore his interests, capacities, and abilities.	4
12. To develop the ability to evaluate.	4
13. To develop the ability to locate problems.	4
14. To acquire a knowledge of the applications of principles in industry.	3
15. To develop the ability to generalize.	3
16. To acquire ideals or habits of accuracy, persistence, honesty, self control, truth, etc.	3
17. To develop attitudes of appreciation in science.	3
18. To acquire an aptitude for investigation in science	3

19. To acquire an interest in taking more science. 3

20. To acquire the knowledge necessary to correct superstitutions and erroneous beliefs. 2

21. To develop the power of observation. 2

22. To develop the ability to recognize defects and errors in conditions and processes. 2

23. To revise one's opinions if the evidence warrants. 2

24. To appreciate the contributions of science to mankind 2

25. To appreciate nature. 2

26. To evolve high standards of conduct in personal and group life. 2

27. To acquire interests in vocational fields. 2

The remaining objectives mentioned by these thirteen bibliographies are mentioned in but single instances.

Comparing the objectives obtained by Beauchamp, which are of more recent origin than many of the objectives in the tabulation above, (which includes the objectives of Beauchamp), in regard to their frequency of mention we find some interesting facts.

We find that Beauchamp has reversed the order of the first and second objectives as compared with the older set of objectives.

Out of the first ten objectives in each list we find seven the same, namely, to develop the ability to think scientifically, to acquire knowledge that will produce a better understanding of environment,health,citizenship,to acquire information about science,to acquire wholesome interest which may be used to enjoy spare time,and worthy use of leisure time.The objective to acquire wholesome interest which may be used to enjoy spare time is considered the same as worthy use of leisure time.

The remainder of the objectives of both sets,those of Beauchamp and those of the thirteen authorities seem to be quite jumbled in relation to each other.For example,the objective which Beauchamp lists as fourth,the contribution of science to mankind,is rated in the other list as twenty-fourth. His fifth objective,to develop power of observation,in the other list is rated as twenty-first;whereas his eighth objective,to acquire ideals or habits of accuracy,persistence, honesty,self control,truth,etc.,in the other list is rated as sixteenth.

Comparing both of these lists further,we find little agreement as to the second ten objectives or as to the last seven. Perhaps this results might be taken as a slow recognition by general science teachers,authors,and authorities,as a gradual change in objective in this subject which is still in its process of development.Then again the center of gravity might be shifting to the first three objectives which have a large majority of advocators. These first three objectives are:to develop the ability to think scientifically, to acquire knowledge that will produce a better understanding of environment,and health.

However, analyzing the seven identical objectives out of the first ten in each list, we find that four of them are four principles mentioned by the Committee for the Reorganization of Secondary Education; namely, health, citizenship, worthy use of leisure time, and to acquire wholesome interest which may be used to enjoy spare time, the last mentioned being worthy use of leisure time expressed in different words. The three of the seven that remain, namely, to develop the ability to think scientifically, to acquire knowledge that will produce a better understanding of environment, and to acquire information about science seem to be intermediate objectives; that is, when carried through to completion they take on a different aspect. The ability to think scientifically, and to acquire information about science and environment are merely a means to an end. These abilities can lead to good citizenship, worthy home membership, worthy use of leisure time, good health, and even sound ethics.

Thus, both the general objectives of science education and the specific objectives of general science can be considered merely as the principles of education advanced by the Committee for the Reorganization of Education expressed in different words and phrases: undeveloped principles which will lead to thse objectives advanced by the Committee; or extensions, that is, specific applications of the principles advanced by the Committee. Thus, in determining the objectives of general science as applied to local conditions, I should consider that any objectives which conformed to the principles advanced by the Committee for the Reorganization of Secondary Education would seem permissible to use.

Principles of Organizing a Curriculum

"After the objectives of a course have been formulated, the next step is probably that of determining the general principles which shall function in the selection and organization of materials of instruction. Teachers must understand the principles of organization underlying the curricular materials if they are to use the courses intelligently."(1)

Franklin Bobbit(2) has advanced the following guiding principles and assumptions in drawing up a curriculum.

"1. The first task of the curriculum maker is to discover what science thinking should be done by men and women.

2. All normal persons should do much of their thinking in terms of science and all of their thinking with that intellectual perspective and proportion which can be provided only by science.

3. Science is needed for the right appreciation of the world.

4. The science department should emphasize humanistic and religious vision and inspiration.

5. The use of science should produce intellectual and emotional expansion.

6. Science should give a balanced vision and understanding of the realities near and remote.

7. Emphasis on the technique of a special science does not accomplish any purpose.

(1) Beauchamp, Wilbur L. "Instruction in Science" U.S. Department of Education, Bulletin 1932, number 17, p.15.

(2) Franklin Bobbitt, "How to Make a Curriculum", Houghton Mifflin Company, 1924 Edition, pp. 136-141.

8. As the normal intellectual stature of individuals differs, the levels achieved will differ; but for all, the training should presuppose fullness of growth according to possibility.

9. Man's thinking should be diagnosed in order to determine what aspects of science should be emphasized in the curriculum.

10. Science training should develop interests, and appreciations.

11. For the general training, extensity of vision, interests, and appreciation is important.

12. The science understanding should be a matter of gradually expanding growth.

13. Science interests, visions, and understanding are to be developed by experience mainly on the level of intellectual play.

14. Science of functional applied or work type will have its broad foundations mostly laid on the play level.

15. The science will be of all sorts of legitimate types, pure science, applied science, general science project science, etc.

16. The science thinking should grow increasingly quantitative and should be in those mathematical terms in which persons in general will do their mathematical thinking.

17. Every aspect of the science is to be introduced by contacts with concrete realities.

18. Contacts with the realities of science are to be of normal living types as fully as possible.

19. The science work of the school should be kept in close touch with the affairs of every day life.

20. One's out of school experience should be utilized for the science training as fully as possible.

21. Science phenomena are to be observed in their environment.

22. Much science observation should be in the laboratory.

23. Pictures and charts will be used for observation.

24. There should be interesting readings in several science fields.

25. Reading can be an effective method of presenting concrete realities of science beyond immediate contacts.

26. Reading can reveal the concrete realities the world over.

27. Science readings should be effective for the purposes of indirect values. They should be prepared in compliance with all the cannons of effective literary presentation.

28. The histories of technological developments are largely science narratives of great values.

29. Literature is to be drawn upon for science readings.

30. Biographies of pioneers in scientific exploration and discovery make valuable backgrounds.

31. The habit of science reading should function throughout life.

32. Readings are to be followed by problems.

33. Problems should question cause, effect, possibility, probability, quantity, relation, trend, etc.

34. Problems are to be very numerous and to institute a gradient that is easy.

35. The problems will relate to materials that are presented in various ways; field observation, pictures, charts, etc.

36. There should be mathematical problems for the purpose of making the science factors and relationships clear.

37. Facility in thinking in terms of general laws or principles is to be gained from practice in solving problems.

38. Right attitudes toward accurate scientific methods and skills are to be developed in beginners by confronting them with problems which call for the use of accurate methods.

39. Thinking and expression are inseparably related.

40. Many science activities of pupils will arise in other departments such as hygiene, history, geography, civics, etc.

41. The science needed for any vocation should be determined strictly with a view to that vocation.(1)

C.J.Pieper(2) in an investigation for the National Society for the Study of Education, states the following principles of organization recommended by the Committee:

1. The course shall be organized into units each of which shall be related to some significant aspect of the environment.

2. The unit shall be a problem of everyday life to which science may contribute to the intelligent basis for human adjustment.

3. Each unit shall include only a few principles of science.

(1) Franklin Bobbitt, "How to Make a Curriculum, Houghton Mifflin Company, 1924 Edition, pp.136-141.

(2) C.J.Pieper, "Science in the Seventh, Eighth, and Ninth Grades" National Society for the Study of Education, 31st Yearbook pp.193-221.

4. Each unit shall be divided into subordinate problems to facilitate learning by pupils.

5. The continuity of the unit shall be such that the course develops a story of man's understanding of and adjustment to his whole environment.

6. The organization in part shall be in the form of problems to insure education in problem solving.

7. There shall be relatively few units, so that the pupils will understand the larger relationships of the facts of science.

8. The units shall be so organized that the conceptions of science and their social implications once learned shall be used in more relationships in later units.

9. The inter-relationships of generalizations and their social significance shall be brought to the attention of pupils by abundant cross references and cross exercises.

10. There should be opportunities to apply the generalizations in the interpretations of novel problems and novel phenomena.

11. The units should be organized so that the succeeding units will call for the understanding of larger and larger relationships and conceptions.

12. There should be enough activities to insure accomplishment of the objectives by pupils of different interests and capacities

13. In general the units and subordinate problems within each unit shall proceed in line with the scientific methods of problem solving, that is, a) from sense perceptions of materials, forces, or phenomena to the formulation of ideas, to the testing

of the hypotheses, to the tentative conclusions, and to the application of the conclusions in life situations; or b) from principles or generalizations to the interpretation of specific situations.

14. The distribution to time, and emphasis to the various units shall be determined by the social value of the units, its teachability and learnability, the teacher's and pupil's interest in the unit, the local significance of the unit, and its value to other units of the course.

15. The units shall be so formulated that the pupil will have revealed to him the kinds and nature of the fields of science.

16. The laboratory work shall be included as an integral part of problem solving and have the characteristics of experience.

17. Historical and biographical content shall be introduced.

18. Subject matter shall be so arranged that it will be a means to the solution of problems and not an end in itself.

19. The materials and activities shall be organized around the pupil's life, projecting him into the problems of adulthood.

20. The organization shall be such that it will lead to the attainment of the immediate and ultimate objectives."(1)

Summarizing the principles of drawing up a curriculum advanced by Bobbitt and Pieper, we find that the entire course should be divided into units which in turn are sub-divided into problems in the form of projects, which should develop the story of man's adjustments to his environment. Each unit should

(1) C.J. Pieper, "Science in the Seventh, Eighth, and Ninth Grades", National Society for the Study of Education, 31st Yearbook, pp. 193-221.

be a major problem of every day life including only a few principles of science related to environment and should contain enough activities to insure accomplishment of the objectives by pupils of different interests and capacities,as well as offering progressively difficult activities which should proceed in line with the scientific methods of problem solving.

Scientific attitudes should be developed and an investigation launched to discover what science thinking is being done,and what should be done,any deficiency in this thinking being remedied.

The pupils should gain an understanding of the larger inter-relationships of facts or principles,and their social aspects should be brought to the attention of the pupils.

Scientific principles in every day affairs are to be introduced by concrete living realities viewed in their natural environments.Thus science interests,visions,and understanding,appreciation,inspiration,intellectual and emotional expansion should be developed gradually by experience.

Pictures,charts,reading,and laboratory work develop foundations in science and give indirect as well as direct values.History,literature,and biographies arouse interest,in science and should be followed by problems that require the analytic and interpretative use of laws,principles,and simple mathematics developed gradually by experience.Special sciences should be excluded because they do not fulfull the purpose of growth. The amount of science needed in various vocations should be determined and the courses arranged accordingly. The subject matter should be a means to the solution of problems and not the end in itself and should be organized around the pupil's life.

Types of Organization of Courses

Perhaps the best source of information about the type of organization of courses in use to-day is the report of Beauchamp[1]. He states, "There are three general types of organizations in common use to-day, the topical organization, the specific objective organization and the unit method of organization. The topical method of organization, is the traditional method.

Ninety-three out of the one hundred and sixty courses examined presented simply a topical outline of subject matter. While employment of the topical method of organization does not necessarily indicate that the memorization of subject matter is the most important aim of the course, the material included inthe outline places the emphasis upon the accumulation of details and facts rather than upon understanding.

An examination of the Los Angeles course of study, which is organized in terms of specific objectives, shows that the specific objectives commonly begin with an infinitive. However, if the infinitives are written on one side of the page and the subject matter on the other, a topical outline is had on one side and a series of infinitives on the other. Thus, it may be taken for granted that the teacher wishes the pupils to obtain a knowledge of the topics in an outline.

(1) Wilbur L. Beauchamp, "Instruction in Science", United States Office of Education, Department of Interior, Bulletin 1932, number 17, pp. 15-24.

The unit method of organization-Professor H.C. Morrison(1) states,"A learning unit may be defined as a comprehensive and significant aspect of the environment of an organized science or an art or of conduct which being learned results in an adaptation in personality.The problem of organization in general science is a search for the comprehensive and significant aspects of the environment in the field being studied,comprehensive in that each aspect explains a great deal,and significant in that it is important and essential."(1)

An analysis of the courses divided into units indicates that the term unit has been taken over as a convenient term to replace the word topic rather than as a principle of organization.For example the following units are found in courses in general science:Astronomy,Air,Looking through a Telescope,Bread,Oxygen,Nature of Chemical Change,The Telephone, Buried Treasure,Animals,The Grasshopper,Chemistry,Flowers, Machines,Water,Obtaining a Food Supply,Carbon Dioxide,and How Living Things Grow.It is evident that many of the titles listed are not units in the sense in which Professor Morrison uses the term while others are such units.Many of the courses consist of true units mixed with topics.

An analysis of the unit Air which was included in fifteen of the courses studied seemed to point to several conclusions.1)The idea of what a unit is,is not clearly

(1) H.C.Morrison,"The Practice of Teaching in Secondary Schools" University of Chicago Press,1926 Edition p 21,quoted by Beauchamp.

defined;2)the title of the unit does not indicate the nature of the content to any high degree;3)the emphasis is placed upon the subject matter or assimilative materials rather than upon the elements through which the intelligent attitude implied by the unit is attained in the sense in which the term unit is applied by Morrison.

The results of the complete analysis show that approximately ten per cent of the courses of study consisted of a list of the topics to be covered,and that sixty per cent of the courses consisted of a topical outline of each unit or topic.The remaining thirty-per cent of the courses exhibits a great variety of methods of organization.

Several courses present interesting variation from the dominent procedure.In the course in general science in Rochester,New York,each unit is regarded as a significant understanding and the name is phrased as a complete sentence. Each unit is then divided into a series of minor concepts, also formulated as statements.A series of problems is then raised through the solution of which the pupil arrives at the concepts listed.The emphasis is,therefore,on a generalization or concept which is reached through the mental process of problem solving."(1)

An analysis of the types of organization investigated by Beauchamp show that there are three principle types in use to-day,namely the topical organization,the specific

(1)Wilbur L.Beauchamp,"Instruction in Science",United States, Office of Education,Bulletin 1932,number 17,pp.15-24.

objective organization, and the unit method of organization.

The topical method of organization is the traditional method of organization, and most courses are organized according to this method. The author seems to frown upon this method of organization and seems to intimate that it is "old fashioned". As to the specific objective method of organization, the author in general seems to find it to be incompatible with any underlying viewpoint in education or psychology or learning.

The author seems to prefer the unit type of organization although he points out that much improvement is to be sought in this method of organization, mentioning that the idea of a unit is not clearly defined, that its title many times does not indicate the nature of its content, and that the emphasis is placed upon the subject matter rather than upon the elements through which the intelligent attitude, implied by the unit, is attained.

Having dealt with the general types of organization employed in science, and keeping these principles in mind, let us now turn our attention to the organization of general science and its more specific methods of organization.

Beauchamp[1] states, "Courses in general science were first organized according to the logical division of the whole field of science, For example a section would be devoted to physics, another to chemistry, etc. The Committee on Reorganization in 1920, however, recommended that the subject matter of general science be elected to a large extent from the environment and that the principles of the various sciences be brought in wherever necessary for the interpretation of the environment. Analysis of the fifty-eight courses in general science represented in this analysis disclosed but one course which was organized in terms of the special sciences. Nine courses were found which were hybrids; that is, which consisted in part of topics drawn from the special sciences and in part, of environmental topics. Forty-seven courses were formulated primarily in terms of environmental topics or units."(1)

Ira C. Davis[2] states, "The first factors to be considered are the aims to be developed in the teaching of general science. In the consensus of general science teachers

(1) Wilbur L. Beauchamp, "Instruction in Science," U.S. Department of Education, Bulletin 1932, number 17, monograph number 22, pp. 28-29.

(2) Ira C. Davis, "Organization of General Science in the Seventh, Eighth Grades of the Junior High School and the Ninth Grade of the Four Year High School", School, Science, and Mathematics, 1924, pp. 487-494.

taken it is found that the most important aim is to acquaint the pupils with their environment. This should be followed by stressing the necessity of the pupils gaining a large number of scientific facts. In the organization of a course of study in general science the most important factor to determine is, What is the average environment of a boy or girl?

These units must be arranged in some coherent form. In doing this it is necessary to consider:

a) The seasons.

b) The possibility of demonstration or of experimentation with the subject matter.

c) The difficulties to be encounted in each unit.

d) The possibility of the use of projects.

If we take these factors into consideration, the best possible order to arrange these units is the following; air, water, heat, light, sound, electricity, energy, and machines, simple chemistry, soils, plants, animals, clothing, foods, and modern scientific development.

The experiment problem-project method seems to fulfill all of the aims of general science.(1)

Koos,(2) states, "Science teachers have been seeking a

(1) Ira C. Davis, "Organization of General Science in the Seventh, and Eighth Grades of the Junior High School, and the Ninth Grade of the Four Year High School", School, Science, and Mathematics, 1924, pp. 487-494.

(2) L. V. Koos, "The Junior High School", Ginn and Company, 1927 Edition, pp. 257-259.

principle of organization of content that will make of the courses coherent wholes. The report on the reorganization of science in the secondary schools, suggested organization of the course in general science around topics to which many specific pieces of work are related. Seven sample topics are given; namely, combustion, water, air, and the weather, light, and its benefits, work and energy, magnetism and electricity, and nature's balance of life.

Another organization by units of a course in science for junior high school is presented as illustrative of efforts to secure effective arrangements of content. This course in science is given in the junior high schools in Denver, where three periods per week are devoted to general science in both the seventh and eighth grades and five periods to biology in the ninth grade. The units in the seventh grade science are as follows: the sun's gift of heat; the air we breathe, the waters of the earth, weather and climate, how fuels serve man, science in the household. The eight units in the next grade are: the science of familiar things, the work of the world, how we see, how we hear, the heavenly bodies, time and the seasons, the crust of the earth, life upon the earth. The five units in the ninth grade course in biology are: life in a vacant lot, life in our city parks, life in and about a lake or pond, life on the plains, and in mountains, man in his environment."(1)

Analyzing the above reports on the organization of

(1) L.V. Koos, "The junior High School", Ginn and Company, 1927 Edition, pp. 257-259.

general science courses we find that general science courses were first organized according to the logical divisions of the whole fields of science. However, general science courses to-day, arranged in units, should primarily interpret the environment and secondarily offer a large number of science facts to be gained.

Units of general science may be arranged according to the seasons, the possibility of demonstration or of experimentation with the subject matter, the difficulties to be encountered in each unit, and the possibility of the use of projects. If we take these factors into consideration, the best possible order to arrange these units is the following: air, water, heat, light, sound, electricity, energy, machines, simple chemistry, soils, plants, animals, clothing, foods, and modern scientific development.

The report on the reorganization of science in the secondary schools mentions in the organization of general science courses seven sample topics, namely, combustion, water, air and the weather, light and its benefits, work and energy, magnetism, and electricity, and nature's balance of life to which many specific pieces of work are related. Thus a general science course organized around the above topics, would directly interpret the environment.

The course should also be arranged so that the pupils are taught to experiment and afterward to solve problems similar to the experiment.

Selection of Content

The next step in the study of our problem is to select the subject matter to fit this organization, in which we decide to arrange our general science course.

Pieper[1] states, "We should remember that in choosing the content of general science courses it should lead to those knowledges, skills, interests, and attitudes essential to desirable mental and practical adjustments to the environment as the very existence of the subject is to explain the environment. The content also shall apply to life situations and afford opportunity for the exercise of the creative abilities of youth and for the joy, romance, and adventure that discovery, inventions, and self production in science afford."(1)

The bulletin on the reorganization of science in the secondary school[2] states, "The content also should be chosen on the basis of its fundamental relation to life as dictated by common experience and the needs originally related to them; and should also relate to local industries, community, and school activities and the life of the home. The content should be graded so as to be hard enough to call for the pupil's best efforts and should become increasingly difficult as the pupil develops his power of attack through experience. The content also should contribute to the objectives.

(1) C.J. Pieper, "Science in the Seventh, Eighth, and Ninth Grades", National Society for the Study of Education, 31st Yearbook, pp. 193-221.

(2) "The Reorganization of Science in the Secondary Schools", Bulletin 1920, number 26, U.S. Office of Education, pp. 25-28.

Beauchamp(1)states,"The content many times can be determined by an analysis of human activities,children's and adult's interests,surveys of newspapers and current literature findings of committees based on consensus,and an analysis of mistaken notions and superstitions.It should bear direct significance to life's problems and activities,experience being called for with the materials."(1)

Pollock(2) and Douglas(3)mention also that children's interests condition teaching and should be the basis of what to select in general science.

Curtis(4)states,"In determining content there should be cooperation of the subject matter specialists who insure that the materials are accurate and up to date,the classroom teachers and supervisors having a background of experience who refine the materials in the light of their appropriateness of content and difficulty;and the specialists in the teaching of science who contribute a knowledge of developments in the fields with respect to educational research."(4)

The bulletin on the reorganization of secondary school science further states,(5)"It is not desirable that there

(1)Wilbur L.Beauchamp,"Instruction in Science",Bulletin 1932 monograph 22,pp.38-39.

(2) C.A.Pollock,"Children's Interests are a Basis of What to Teach in General Science",Ohio State University Educational Research Bulletin(January 9,1924) vol3,number 1,pp.3-6

(3)A.A.Douglas,"Secondary Education",Houghton Mifflin Company 1927 Edition,pp.393-400.

(4)F.D.Curtis,"Investigations Relating to the Content of Science Courses"for the committee,National Society for the Study of Education,31st Yearbook,pp.109-221.

(5)"The Reorganization of Science in the Secondary Schools", Bulletin 1920,number 26,U.S.Office of Education, should be a syllabus to which teachers shall adhere but instead enough topics should be presented as illustrations to indicate,clearly the kinds of materials recommended.The topic presented below is one of several based upon a topic actually used in a high school in a city of approximately 150,000 inhabitants.In other schools for example a school in a strictly agricultural community many changes would naturally be made.In the city from which this topic is selected the course varies from year to year according to thettopic on which emphasis is needed.

Topic-Combustion-Why our homes must be heated at times and cooled at other times;sources of heat;kinds of fuels;making a bonfire;lists of questions about bonfires;why the fire burns; lesson on elementary chemistry;elements and compounds;what becomes of wood when burned;oxidation;why stones are not used for fuel,heat produced by oxidation,making a thermometer, effects of heating iron,water and wood,slow heating of water, thermostat,how heat travels,ways for heating a home,how the science room is heated;study of a chimney,what smoke is,how common illuminating gas is made in this city,a study of candle flames;study of Bunsen burner and its uses;carbon dioxide,how produced,body fires relation to physiology:control of fires, losses from fires,and how to prevent them.What is a fire insurance company?Does the insurance rate in this city indicate that fires are more common than elsewhere?

(1) The Reorganization of Science in the Secondary School, Bulletin 1920,number 26,U.S.Office of Education,

Suggestions on Instructional Technique

How shall we teach general science? Are there any suggestions as to instructional technique? Yes, there are but many of these are open to discussion as they remain unsolved problems. However, we shall examine some of the generally accepted methods as well as those still open to discussion.

"Method means a way to a result, a means to an end, a path to a goal. Without a clear notion of the end we cannot proceed intelligently upon the journey toward it.

In general science a person who is an expert in scientific knowledge forgets, for the time, the conventional discussions of science and puts himself at the standpont of the pupil's experience of natural forces to-gether with their ordinary useful applications. To him as a teacher the material is simply a means, a tool, a road."(1)

Beauchamp[(2)] states, "The low frequency of suggestions as to instructional technique indicates that curriculum makers as a whole do not believe it necessary to include suggestions on methods of teaching. Committees in general believe that the method of teaching should not be prescribed that the individual teacher should be permitted the utmost freedom."(2)

P.G. Edwards[(3)] mentions, "To teach general science efficiently it is necessary to consider some preliminary work in organization to determine what the study of general

(1) John Dewey, "Method in Teaching Science", N.E.A. Addresses and Proceedings 1916 vol.54, pp.729-737.
(2) Wilbur L. Beauchamp, op. cit. p.42.
(3) P.G. Edwards, "Teaching General Science", Chicago Schools Journal, (January, 1932) pp.213-215.

science should aim to accomplish.

There is a high degree of correlation in attainment of larger aims.

1. Understanding and appreciation of scientific problems should be developed that pupils may learn to control their environment.

2. The solution of problems should be attempted by the scientific method. First, the problem must be stated clearly. Second, a procedure must be devised which will yield evidence leading toward solutions. Third, evidence must be interpreted. Fourth, the conclusions must be drawn and applied to the original problem.

3. Induce an emotional response in some students which will inspire them to continue to study in the field of science. It will be manifest in several ways; first, it will appear in the form of an increased interest in the work at school; second, it may carry over into voluntary home work; third, it may result in a desire to follow one or more of the specialized sciences. The ability to induce this emotional response distinguishes the teacher who has made his work an art from the teacher who regards it as ordinary business."(1)

Many authors favor the use of motion pictures in the teaching of general science. Ira. C. Davis(2) states, "Many kinds of material have been adapted to film presentation. Pictures illustrating manufacturing processes offer products such as "The Making of Cotton Cloth," "The Making of lumber," It would

(1) P. G. Edwards, "Teaching General Science", Chicago Schools Journal, (January 1932) pp.213-215.

(2) Ira C. Davis, "The Use of Motion Pictures in Teaching General Science". School, Science, and Mathematics, (Jan. 1923) pp. 425-34.

probably be impossible to present this material in another form. If the material in these pictures is presented scientifically, it ought to be a great aid in dveloping broader concepts of the value of science in our industrial processes. Many of nature's slow and tedious processes can through the use of films be speeded up so that the work of weeks or months may be shown in a few minutes.

There are several methods in preparing the classes for the films. It is sufficient briefly to outline the different methods that might be used.

1. The films can be given without any previous discussion.
2. The films can be given to contine some theoretical discussion initiated in the laboratory or classroom discussion.
3. The films can be a summarization of a group of processes or it can follow the completion of some study.
4. The pupils can prepare questions for the films to answer.
5. The films can take the place of some experimental work in the laboratory. Students could draw their conclusions from the facts presented in the films.[1]

C.C. Clark[2], after giving a series of tests to determine the worth of sound pictures, states, "The tests warrant the following conclusions as regards the value of sound pictures.

1. Education sound films of the lecture type were compared with

(1) Ira C. Davis, "The Use of Motion Pictues in Teaching General Science", School, Science, and Mathematics, (January 1923) pp. 425-434.

(2) C.C. Clark, "Sound Motion Pictures as an Aid in Teaching Science", Science Education, (February 1933) pp. 17-23.

the silent films. The use of the spoken lecture in place of the printed captions in an educational picture is most likely to detract from its value in conveying specific information.

2. Sound motion pictures where the sound was a vital and realistic part of the picture were shown to be equally effective as the lecturer performing and explaining actual demonstrations. Such sound films are highly valuable for classroom use."(1)

"The use of pupil lesson sheets is also recommended as one of the methods of teaching general science. The use of pupil lesson sheets in general science in one of the Denver junior high schools has met with encouraging results. Copies of the lesson sheets given to the pupil form a basis for the organization of the ideals gleaned from his textbook, supplementary reading, observation, class discussion and demonstration. The sheets usually contain a series of questions the answers to which may be found in his textbook besides topics and questions for class discussion. These stimulate original thought and research."(2)

Ralph K. Watkins(3) states, "Some of the important trends and tendencies of general science teaching are:

1. A reduction in individual laboratory work, and an increase in demonstrations and visual instruction.

2. An increased flexibility in the type of laboratory work.

(1) C. C. Clark, "Sound Motion Pictures as an Aid in Teaching Science", Science Education, (February, 1933) pp. 17-23.

(2) Glen L. Gebhardt, prepared for the Department of Superintendent's Fifth Year Book, 1927, p. 173.

(3) Ralph K. Watkins, "Some Recent Tendencies in Teaching Procedures for General Science", General Science Quarterly, (March, 1929) pp. 140-146.

3.A reduction in writing experiments,and in notebook work.
4.The use of individual and committee reports and pupil demonstrations to provide for individual differences.
5.The formation of science clubs.
6.The uses of projects as a part of instruction.
7.The unit organization instead of daily lesson organization.
8.Programs of discussion and reading.
9.The use of work sheets,direction sheets,and unit outlines.
10.Objective tests to be given for particular lesson units."(1)

"Two principles seem to underlie most of the discussion of projects.The first principle is that the child shall be engaged in some activity either manual or mental,and the second is that this activity shall be motivated through the child's own desire to do the thing because it appeals to him as worthwhile.A project suggests a question or problem demanding a solution."(2)

Watkins(3) investigating the problem as to whether project teaching secures as good results with pupils in general science as the traditional types of teaching states, "It seems probable that project teaching insures the attainment of more aims,gives a greater possibility of learning in general, should induce better learning growth,insure increased expenditure of effort on the part of pupil,develop greater

(1) Ralph K.Watkins,"Some Recent Tendencies in Teaching Procedures for General Science",General Sci.Quart.(Mar.1929)pp.140-146.
(2) G.H.Trafton,"Project Teaching in General Science",School, Science,and Mathematics,(April 1921) pp.315-322.
(3) Ralph K.Watkins,"The Technique and Value of Project Teaching in General Science",General Science Quarterly,(May 1923) pp.235-56.

initiative and independence, gives a greater opportunity for "problem solving attitude", encourages a wider range of reading, provides deeds better for the needs of pupils of varying capacities and provides better opportunities for real and genuine teaching and for teacher growth than in traditional types of teaching."(1)

Orlie M. Clem(2) states, "A study of school projects will make clear that situations conducive to worthwhile projects are sometimes hit upon by accident, sometimes planned by the teacher and sometimes waited for. In order that a course of study may be carried out the situations must obviously be mainly planned. It matters little whether the teacher prepares the situation and suggests the purpose or whether the pupils hit on it unaided. However the teacher will choose his leads."(2)

Erma B. McCaffrey quoting Professor W.L. Eikenberry(3) states, "Projects may be divided into four types as follows:

a. Construction type, where the purpose is to embody some idea or plan in external form such as building a boat.

b. Appreciation, type where the purpose is to enjoy some aesthetic experience.

c. Intellectual type, where the purpose is to solve some problem.

d. Skill or habit forming type, where the purpose is to obtain

(1) Ralph K. Watkins, "The Technique and Value of Project Teaching in General Science", General Science Quart. (May. 1923) pp. 235-56.

(2) Orlie M. Clem, "The Application of the Project Technique to a Course in General Science", Journal of Educational Method (May 1926) pp. 397-402.

(3) W.L. Eikenberry quoted by Erma B. McCaffrey, "The Laboratory-Problem-Project Method of Teaching General Science", School, Science, and Mathematics, (December 1926) pp. 966-973.

some degree of skill or knowledge.

Projects of the type c and d are not usable in general science. The teacher will have to consider each project selected to see that the solution is possible by the student who has chosen it, considering his experience and knowledge of subject matter."(1)

Nellie M. Jaroleman(2) mentions, "Some of the ways of making general science interesting to pupils are: teaching proper laboratory technique, using several different textbooks, at the beginning of the term placing the general plan of the work on the board, having group work, vocabulary and spelling drills, teacher and pupil demonstrations, picture collections, seasonal room collections, outside reading and lectures, outside speakers, visual aids, animal care, and club meetings."(2)

Ellis C. Persing(3) and A. C. Murphy(4) recommend as aids in teaching general science "pictures, exhibits, and models, lantern slides, and films, science magazines, voluntary home work, original discussions on any scientific subject, field trips, science trips, and a science newspaper."

Summarizing the many suggestions as to how teach general science we obtain many interesting and practical suggestions of presenting this material.

(1) W.L. Eikenberry quoted by Erma B. McCaffrey, "The Laboratory-Problem-Project Method of Teaching General Science", School, Science, and Mathematics, (December, 1926) pp. 966-973.

(2) Nellie M. Jaroleman, "Making General Science Interesting", School, Science and Mathematics (June 1931) pp. 727-729.

(3) Ellis C. Persing, "Supplementary Aids in Teaching General Science", General Science Quarterly, (March 1929) pp. 155-160.

(4) A.C. Murphy, "Aids in Teaching General Science", School, Science and Mathematics, 1927, (May, 1927) pp. 481-288.

Although the personality of the teacher is said to determine results vastly more than any method of instruction, it would seem as though a lesson taught by a certain method or plan would be more practical than one taught spontaneously.

In solving problems of life the problem must be stated clearly, a procedure must be devised which will yield evidence leading toward solutions, evidence must be interpreted, and the conclusions must be drawn and applied to the original problem. An emotional response should be induced in students which will inspire them to continue to study in the field of science.

Projects are found to motivate the child's own desire to do things because they appeal to him as worthwhile. Project teaching seems to insure the attainment of more aims, gives a greater possibility of learning in general, should induce better learning growth, insure increased expenditure of effort on the part of the pupils, develop greater initiative and independence, give a greater opportunity for a "problem solving attitude", encourage a wider range of reading, provide deeds better for the needs of pupils of varying capacities, and provide better opportunities for real and genuine teaching and for teacher growth than in traditional types of teaching. It matters little whether the teacher prepares the situations for the project and suggests the purpose or whether the pupils suggest them unaided.

It would probably be impossible to teach many industrial processes other than by moving pictures. Many of the slow and tedious processes of nature require more time to observe than many classes in general science can spare;but through the use of films these processes can be speeded up,so that the work of weeks can be shown in a few minutes by the films.

There are several methods of preparing the class for the films.The films can be given without any previous discussion,can be given to continue some theoretical discussion initiated in the laboratory or classroom discussion,can be a summarization of a group of processes or these films can follow the completion of some study,the pupils can prepare questions for the films to answer,and the films can take the place of some experimental work in the laboratory.

In the showing of "talkies" the use of the spoken lecture in place of the printed captions in an educational moving picture is most likely to detract from its value in conveying specific information.Sound films of the type in which the sound is a vital and realistic part of the pictures are highly valuable for classroom use.

Pupil lesson sheets which form a basis for the organization of the ideas gleaned from textbooks,supplementary reading,observation,class discussion,and demonstration represent an interesting process of development from the original syllabus to the present day form for pupil use.

An increase in demonstrations and various devices for visual instruction,the use of individual and committee reports and pupil demonstrations,the formation of science clubs, unit organization instead of daily lesson organization, programs of discussion, reading done for values which may be derived from reading, and the use of objective tests are recommended.

Other aids recommended for use in the teaching of general science are: science libraries, talks by pupils, field trips, use of the bulletin board, current events, question boxes, books for advanced study, guide sheets, science exhibits, science assemblies, sample lessons, interpreting drawings, maps, statistics, and graphs, drawing from description and observation, manipulating in laboratory experimentation, making collections, repairing appliances, constructing models, appliances, etc., making local surveys, and performing other activities useful in the development of a unit.

In addition, each general science period should be so planned that there is a short review as well as advanced work accomplished.

Examination of Textbooks in General Science

Possibly a good way of determining the content of general science courses as they are being given throughout the country today is by an examination of some of the textbooks in general science published by some of the leading publishing companies.(1)-(7) Analyzing these textbooks in respect to the amount of space devoted to each topic, and then arranging the topics in the order of space allotted, we obtain the following table.

Topic — Number of pages ---	1	2	3	4	5	6	7	Total
Air and its uses	-	76	57	95	41	66	10	345
Water and how we use it	38	29	29	46	50	29	32	253
Food	43	15	31	71	21	47	21	249
Magnetism and electricity	35	40	18	28	50	25	42	238
Weather and climate	41	28	31	28	32	25	28	213
Machines, force and energy	37	45	13	25	31	45	12	208
Heavenly Bodies	85	40	9	-	33	19	19	205
Light	37	27	15	32	36	31	14	192

(1) Pieper and Beauchamp, "Everyday Problems in Science", Published by Scott, Foresman Company, Revised Edition, 1933
(2) John C. Hessler, "The First Year of Science", Published by Benjamen H. Sanborn and Company, Revised Edition, 1932
(3) William D. Pulvermacher and Charles H. Vosburgh, "The World About Us," Published by D.C. Heath and Company, 1930 Edition,
(4) Vanburkirk, Smith, and Nourse, "The Science of Everyday Life", Published by Houghton Mifflin Company, 1930 Edition,
(5) Otis William Caldwell and Francis D. Curtis, "Introduction to Science" Published by Ginn and Company
(6) Hunter and Whitman, "Problems in General Science", Published by American Book Company, 1930 Edition.
(7) Clement, Collister, and Thruston, "Our Surroundings, An Elementary General Science", Published by the Iroquois Publishing Company, 1928 Edition.

Topics	1	2	3	4	5	6	7	Total
The human body	-	59	43	-	22	-	60	184
The Plant world	-	27	21	23	69	-	40	180
Obtaining energy from fuels(heat)	34	-	10	23	64	-	35	166
Transportation	35	-	-	33	23	39	33	163
Protection from infectious diseases	35	-	38	-	-	27	14	114
Communication	40	-	-	16	19	31	-	106
How we can keep in good physical condition	37	14	-	-	-	33	12	96
Selection and care of clothing	29	6	-	25	-	21	-	81
Sound	-	32	11	-	-	-	9	52
Place and time	-	-	9	-	14	23	-	46
Economic importance of animals	-	16	-	-	26	-	-	42
Radio	-	-	-	37	-	-	-	40
Micro-organisms	-	-	19	-	-	-	19	38
Rocks and soils	-	17	-	-	-	-	19	36
Inter-dependence of living things	-	-	-	-	24	-	11	35
Importance of matter	-	-	-	-	12	-	21	33
First Aid	-	-	4	-	-	-	9	13

Glancing through the above table, it is seen much space is given to the units, air, and its uses, water and how we use it, food, magnetism and electricity, weather and climate, machines, force and energy, and heavenly bodies. There is a fair amount of space given to the units, the human body, light, the plant world, obtaining energy from fuels, (heat) transportation, and protection from infectious diseases. There is little space allotted to the units, communication, how we can keep in good physical condition, selection and care of clothing, sound, place and time, economic importance of animals, radio, micro-organisms, rocks and soils, inter-dependence of living things, importance of matter and first aid.

Professor Ira C. Davis [1] in an analysis of textbooks arranges the topics advanced by these textbooks in the order of their frequency of mention. He then divides them into three divisions, those having high, fair, and little agreement.

Comparing the above results with those of Professor Davis, we find that they agree in respect to air, water, weather, and climate, electricity and magnetism, and machines, force and energy being allotted to first place. Davis, however, allots first place to the units, plants, and the human body which only show fair agreement in this analysis. This analysis gives high agreement to the units food, and heavenly bodies which Davis mentions only as fair agreement. Both analyses give fair agreement to heat and light. Davis gives fair agreement to rocks and soils whereas only little agreement is given by this analysis. Both agree that the units, animals, and clothing deserve but slight importance. There are some units in this analysis not mentioned

(1) Ira C. Davis, "Analysis of the Subject Matter in the Eight Most Widely Used Textbooks in General Science" School, Science, and Mathematics, (June 1931) pp. 707-714

by Davis i.e. how we can keep in good physical condition, protection from infectious diseases,communication,transportation, inter-dependence of living things,importance of matter, place and time,radio,first aid and micro-organisms.

Are there any conclusions that might be drawn from this comparison of topics?Perhaps,the best conclusion that could be drawn would be for those curriculum makers in search of the subject matter of general science to accept the topics which both analyses mention as having high and fair agreement and localize their course around these topics, which are the units air,water,weather,and climate,electricity, and magnetism,machines,force and energy,plants,the human body,food,heavenly bodies,heat,and light.

Perhaps the topics such as keeping in good physical condition,communication,transportation,radio,first aid,and time and place which are mentioned in this analysis and ignored in Davis's show a goal toward which general science is moving and topics chosen from this group would not be amiss if chosen with care.

Laboratory Work in General Science

The laboratory work in general science is at present, as it has been in the past, a point of contention among many of the educators. Most educators believe in laboratory work in general science. Project work in general science after all is another way of performing experiments, and there are many advocates of the project method. The main point of contention seems to be whether laboratory work in general science should be separated from the work in the textbooks, as has often been the case of the specialized sciences in the past, or should we have the teacher or pupil demonstration in place of individual experimentation.

Beauchamp(1) states, "The organization of courses in terms of problems has unified laboratory and textbook work. The solution of problems has been elevated to the focus of attention. The data obtained from the laboratory and the textbook are thus used as sources of data. Certain types of experiments are adapted to initiation of work and others for verifying, paralleling, or supplementing the regular classroom work."(1)

In the bulletin for the reorganization of science in the secondary schools(2) "The data collected in many experiments are an end in themselves. There is no further use for them and hence they have no significance for the pupil. Such "Busy work" serves no worthy purpose."(2)

It is thus seen that laboratory work unconnected with the

(1) Wilbur L. Beauchamp, op. cit. pp. 52-53, 63.
(2) The Reorganization of Science in the Secondary Schools, Bulletin 1920 no 26, Department of Interior, U.S. Office of Education.

science course is useless to the pupil. In other words the laboratory work should supplement the class work and not be separated from it.

Edwards[1] also advocates the union of the laboratory and the classroom work.

Analyzing the opinions of the above authorities we see that the tendency to have laboratory work separated from the classroom work is rapidly disappearing. The opinion to-day seems to be that the laboratory work should supplement the class work; they should run hand in hand, one a complement of the other.

Should we have teacher or pupil demonstration in place of individual experimentation? F. D. Curtis[2] states, "At the beginning of this century the prevailing practice in the majority of American secondary schools was to conduct laboratory experimentation on the individual basis. Because of the increasing numbers of pupils, it became obvious that the rapidly mounting cost of apparatus and equipment adequate for individual pupil experimentation prohibited the continuance of that method exclusively, especially in the more widely elected or required elementary courses such as general science and biology. Two plans were suggested, the group method of two or three pupils and the demonstration method

(1) P. G. Edwards, "Teaching General Science", Chicago Schools Journal 14: (January, 1932) pp. 213-215.

(2) Francis D. Curtis, Summarizing for the Committee, The 31st Yearbook of the National Society for the Study of Education, pp. 97-103.

by which a pupil or the teacher performed the laboratory exercise individually."(1)

The Committee of the National Society for the Study of Education(2) summarizing the opinions of various authors (3)-(9) states,

"1. Each method offers training in certain knowledges, skills, and habits not offered by the other.

2. In the interests of economy both of time and of money it seems desirable to perform more laboratory exercises by the demonstration than by the individual method.

3. At the beginning of the laboratory period there should be

(1) Francis D. Curtis, Summarizing for the Committee of the National Society for the Study of Education, 31st yearbook, pp. 97-106.

(2) The Committee for the National Society for the Study of Education, 31st yearbook, 1932 pp. 97-106.

(3) Elliott R. Downing, "A Comparison of the Lecture-Demonstration and Laboratory Methods of Instruction in Science", School, Review 33:1925 pp. 688-697.

(4) Kiebler, F. and Woody, Clifford "The Individual Laboratory versus the Demonstration Method of Teaching Physics", Journal of Educational Research (January 1923) pp. 50-58.

(5) Palmer O. Johnson, "A Comparison of the Lecture-Demonstration Group-Laboratory Experimentation and Individual Laboratory Experimentation Method of Teaching High School Biology", Journal of Educational Research, (September 1928) pp. 103-111.

(6) Clarence M. Pruitt, "An Experiment on the Relative Efficiency of Method of Conducting Chemistry Laboratory Work" Master's Thesis University of Indianna, 1925.

(7) W. W. Knox, "The Demonstration Method versus the Laboratory Method of Teaching High School Chemistry", School Review, (May 1927) pp. 376-386.

(8) W. W. Carpenter, "Certain Phases of the Administration of High School Chemistry", Teachers College, 1926.

(9) Ralph Horton, "Measurable Outcomes of Individual Laboratory Work in High School Chemistry", Teachers College, 1928.

sufficient use of the demonstration method to acquaint the pupils with apparatus and methods of experimentation. The pupils then should be allowed to perform some exercises individually, to acquire desirable manipulatory skill and laboratory technique and habits.

4. Time saved by the use of the demonstration method should be used for other types of activity such as reading, projects, individual investigations, observations, and drill.

5. Dangerous experiments and those requiring delicate manipulation, accurate observation and expensive apparatus should be demonstrated.

6. With younger or less capable pupils demonstrations by the teacher are likely to prove more effective than individual experiments by the pupils."(1)

Harry A. Cunningham(2) in addition to agreeing with the Committee as respects economy of time, and difficult and dangerous experiments states, "In an experiment that must run from day to day, such as the one on osmosis, the pupils will take more interest in making the observations if they have been active agents in setting up the experiment and will give better reports on the experiment."(2)

Beauchamp(3) states, "In the schools visited the large majority of classes in general science were taught by the

(1) National Society for the Study of Education Committee, op. cit.
(2) Harry A. Cunningham, "Individual Laboratory Work Versus Lecture Demonstration in High School Science, School, Science, and Mathematics, (June, 1923) pp. 526-530.
(3) Wilbur L. Beauchamp, op. cit. pp. 52-53.

demonstration or pupil demonstration method.No school was visited in which the special sciences were taught wholly by the demonstration method.This is due in part to the demands of colleges and other standardizing agencies,and in part to the lack of belief on the part of teachers of special sciences as to the validity of the findings of the experiments which have been carried on and in part to the fact that many of the teachers have never heard of the experiments."(1)

Analyzing the above opinions it is seen that in the interests of both economy and money the demonstration method is superior to the individual laboratory method.Each method offers certain knowledges,skills,and habits not offered by the other.The demonstration method is the more satisfactory,in results obtained in the use of tests and exercises.The demonstration method is superior to the individual method when complex apparatus is used or a complex procedure is followed.The individual method is best when college entrance requirements must be met.The demonstration method is better when dangerous experiments are performed.The individual method develops desirable manipulatory skill and laboratory technique and habits.In experiments involving familiar apparatus and easy methods of procedure the individual method is superior.

Thus it is seen that both methods have their advantages although the arguments for the demonstration method seem to the general science teacher to carry the most weight.It would

(1) Wilbur L.Beauchamp,op.cit.pp. 52,53.

seem that the logical thing would be to teach chiefly by the use of the demonstration method,but occasionally allow the pupils to use the individual method when circumstances and conditions permitted.Particularly could the individual method be used in those experiments which are not so technical but that they might be done at home,such as the tests for starch,fats, water,etc.;the preparation of nitrogen(by burning out the oxygen from a container),the study of its properties,etc.

The values of general science are many. Summarizing the opinions of various authors, we obtain the following values for general science.

1. It furnishes usable knowledge to the pupil who leaves school early.[1][2]
2. It furnishes a fundamental foundation for the special sciences.[1]
3. Those who have had general science show a definite gain in physics, and chemistry.[3][4][5]
4. It arouses interest in science and in the environment.[11][3][6]
5. It helps in the health of the student, family, and community.[7]
6. It serves the purpose of exploration in science[6][8]
7. It helps in the choice of vocations.[6][8][9]
8. It interprets home and social environment.[8]
9. It has a special appeal to adolescent boys and girls, helping them to cope with the material world about them.[6]
10. In the study of general science, fields of reading, work, and study are discovered.[6][10]
11. It teaches the scientific method of thinking.[6]
12. It prevents gullibility.[6]
13. It teaches useful methods of solving problems.[11]
14. It stimulates the pupil to more direct and purposeful activities and leads to a higher appreciation of the pleasure and profit to be obtained by the exercise of the pupil's abilities.[11]
15. It gives the pupil control of a large body of facts and

principles significant in the home, school, and community.(11)(12)

16. It has a cultural and aesthetic value.(11)

(1) W.R.Lecker, "The Articulation of General Science with Special Sciences", School, Science, and Mathematics, (October 1925) pp.724-737.
(2) C.O.Davis, "Junior High School", World Book Company, 1926 Edition, p.211.
(3) Harry Carpenter, "A Suceess in Physics and Chemistry in Relation to General Science and Biology", Science Education, (May 1930* pp.589-99.
(4) A.W.Hurd, "Progress Report on the Development of Teaching Units in High School Physics", North Central Association Quarterly, 1930, pp.257-293.
(5) George Mounce, "Some Tangible Results from a Course in General Science", School, Science, and Mathematics, (October 1920) pp.632-636.
(6) John J.Birch, "The Aims of General Science", School Executives, (July 1929) pp.511-12.
(7) Lewis Elhuff, "The Relation of General Science to Later Courses in Physics and Chemistry", National Educational Association, Addresses, and Proceedings, 1916, pp.710-712.
(8) James M.Glass, "Curriculum Practices in the Junior High School and in Grades Five and Six", University of Chicago Press, (November 1924) Monograph 25, p.51.
(9) Henry P.Hailey, General Science as a Foundation Stone", School, Science, and Mathematics, (November 1924) pp.829-833.
(10) W.F.Roecker, "What Makes the Course in General Science Worthwhile", School, Science, and Mathematics, 1923pp.417-424.
(11) The Reorganization of Science in the Secondary School, Bulletin 1920, number 26, pp.15-28.
(12) Ellis Haworth, National Educational Association Addresses and Proceedings, 1932, p. 470.

Summary and Conclusions

General Science does not consist of sections borrowed from other sciences and loosely joined to-gether. On the contrary, it is the study of the scientific facts and laws which relate to our environment, and obtains its proofs from the other sciences whenever these proofs are needed.

In the beginning various sciences such as biology, physics, and chemistry were combined into one course and were known as general science. Later this combination of courses known as general science became adapted more and more to local needs and a study of the environment.

To-day most courses have broken away from the old methods and some of them draw from the various scientific fields the material needed for the problems they present.

General Science was first introduced into the ninth grade. To-day, however, it is beginning to find its way down into the seventh and eighth grades.

The number of pupils to-day studying general science has so increased that there are as many pupils studying general science as there are any of the other sciences. In many schools it is now a required subject as it meets the demand for an elementary science which will serve as a prerequisite course for the more advanced science, and it also can be organized with reference to the pupil's maturity.

The committee method of preparing courses of study seems to be the method agreed on by most authorities as better than that of having an individual prepare a course of study. There are four general types of committees, namely committees operating under a supervisor of science, committees operating under a director of curriculums, committees operating under the direction of outside talent, and committees operating without any supervision.

A committee of teachers operating under a supervisor of science would seem the best qualified to prepare a course of study in science. However, this should depend on local conditions as an untalented supervisor and a careless group of teacher would not accomplish much good.

The general objectives of science education mentioned by authorities seem to be merely extensions of the following principles-health, worthy home membership, vocation, citizenhip, worthy use of leisure time, and ethical character-advanced by the committee for the reorganization of secondary education or the same principles expressed in different words and phrases.

In investigating the specific objectives of general science a list was compiled of the objectives advanced by various authorities in respect to their frequency of mention. This list was then compared with the objectives of Beauchamp, which were likewise listed.

Beauchamp reverses the order of the first and second objectives as compared with the older set of objectives, that is he places the objective "o develop the ability to think scientifically" first and the objective, "To acquire knowledge that will produce a better understanding of the environment " second.

Each list agrees on seven of its first ten objectives; namely, to develop the ability to think scientifically; to acquire knowledge that will produce a better understanding of environment; health; citizenship; to acquire information about science; to acquire wholesome interest which may be used to enjoy spare time; and worthy use of leisure time. (the objective to acquire wholesome interest which may be used to enjoy spare time is considered the same as worthy use of leisure time.) The remaining objectives of both lists differ radically as to their places in regard to frequency of mention.

This result might be considered as a change in objectives in general science which evidently is still in its process of development; or the center of gravity might be shifting to the first three objectives, which have a large majority of advocators over the other objectives. The first three objectives are: to develop the ability to think scientifically, to acquire knowledge that will produce a better understanding of environment, and health.

Analyzing the seven identical objectives mentioned above, we see that they are simply the principles of secondary education mentioned by the committee for its reorganization.

Therefore, an administrator casting about for the objectives of general science in forming a course of study will not go amiss if he chooses any of the seven Cardinal Principles recommended by the Committee for the Reorganization of Secondary Education. However, he should take care to adapt his selection to the local environment as local conditions might call for stress on certain principles, whereas other principles might not be so necessary. A thorough study of local conditions and needs is necessary before attempting the choice of objectives.

Analyzing the opinions of the authorities in respect to drawing up a curriculum, we find that the entire course should be divided into units which in turn are sub-divided into problems in the form of projects. The material should be such as to insure accomplishment of the objectives by pupils of different interests and capacities.

Scientific attitudes should be developed and an investigation launched to determine what deficiencies in scientific thinking should be remedied. Scientific principles in everyday affairs are to be intorduced by concrete living realities viewed in their natural environment.

Pictures, charts, reading, and laboratory work which develop foundations in science and give indirect as well as direct values should be considered when drawing up a curriculum.

The amount of science needed in various vocations should be determined and the courses arranged accordingly. The subject matter should be a means to the solution of problems and not the end in itself and should be organized around the pupil's life.

Thus, it is seen the main idea to be considered in drawing up a curriculum is, of what use is this material to the pupil in his post school days? The material should be considered as a means to an end and should be selected accordingly.

There are three principle types of organizations in use to-day, the topical organization, the specific objective organization, and the unit method of organization. The topical method, which is the traditional method of organization, seems to place the emphasis upon the accumulation of details and facts rather than upon understanding. The specific objective method of organization seems to be the same as the topical method except that the topics begin with an infinitive.

The unit type of organization seems to be the preferred method of organization. However, care should be taken that its title should indicate the nature of its content, and that the emphasis should not be placed upon the subject matter.

Thus an administrator forming a general science course should organize it according to the unit method of organization. Each unit should be regarded with a significant understanding and be divided into a series of minor concepts formulated as statements. The emphasis should be on a generalization or concept which is reached through the mental process of problem solving.

Investigating the more specific method of organizing general science courses, we find that they should not be organized according to the logical divisions of the whole field of science but should be arranged in units which should primarily interpret the environment and secondarily offer a large number of science facts to be gained.

These units may be arranged in various ways, according to the seasons, the possibility of demonstration or of experimentation with the subject matter, the difficulties to be encountered in each unit, and the possibility of the use of projects. Considering these factors, the best possible order in which to arrange these units seems to be the following: air, water, heat, light, sound, electricity, energy, machines, simple chemistry, soils, plants, animals, clothing, foods, and modern scientific development.

However, it would seem that an administrator would have to consider his local needs and environment before determining what topics to use and their possible arrangement; for example it would be easier to study soils and plants in the spring and early summer than in the middle of the winter

There seems to be many ways of teaching general scienece. Most authorities agree that some method or plan is needed. In solving problems of life in general science, a procedure should be devised which will yield and interpret evidence leading toward a solution. The conclusions then must be drawn and applied to the original problem. An emotional response should be induced which will inspire pupils to contine in the field of science.

According to a consensus of opinion, project teaching seems to insure the attainment of more aims, gives a greater possibility of learning in general, should induce better learning growth, insure increased expenditure of effort on the part of the pupils, develop greater initiative and independence, give a greater opportunity for "problem solving attitude", encourage a wider range of reading, provide deeds better for the needs of pupils of varying capacities, provide better opportunities for real and genuine teaching and for teacher growth than in traditional types of teaching. It matters little whether the teacher prepares the situations for the probject and suggests the purpose or whether the pupils suggest them unaided.

There seems to be ample opportunity in general science for the use of the probject. This does not necessarily mean that the subject should be taught by the project method alone, but that there are many opportunities in the subject where it seems to be more adapted than any other method.

Many of the slow and tedious processes of nature studied in general science can be speeded up by the use of motion pictures. Sound films of the type in which the sound is a vital and realistic part of the pictures are highly valuable for classroom use. However, "talkies", in which the spoken lecture is used in place of the printed captions, are likely to detract from its value in conveying specific information

There are several methods of preparing the class for the films. The films can be given without any previous discussion, can be given to continue some theoretical discussion initiated in the laboratory or classroom discussion, can be a summarization of a group of processes or it can follow the completion of some study, the pupils can prepare questions for the films to answer, and the films can take the place of some experimental work in the laboratory.

Other aides recommended for the teaching of general science are: pupil lesson sheets, demonstrations, visual instruction, individual and committee reports, pupil demonstrations science clubs, unit organization instead of daily lesson organization, programs of discussion, reading science libraries field trips, use of the bulletin board, current events, question boxes, science exhibits, science assemblies, manipulating in laboratory experimentation, making collections, repairing appliances, and making local surveys.

Thus, it is seen that a teacher has many methods to choose from in teaching general science. Again, it would seem that local conditions would determine what methods to use. The chief factor in the choice of methods would seem to be that of the type and intelligence of the class. Most likely these methods would have to vary from year to year to meet the capabilities and intelligence of new classes.

In determining the content of general science courses by analyzing several textbooks, I arranged a list of topics in the order of space allotted to each topic. Comparing this list with a list advanced by Professor Ira C.Davis,we find that they agree in respect to air,water,weather,and climate, electricity,magnetism,machines,force and energy being allotted to first place.Davis,however allots first place to the units,plants,and the human body which only show fair agreement in this analysis.This analysis gives high agreement to the units,food and heavenly bodies which Davis mentions only as fair agreement.Both analyses give fair agreement to heat and light.Davis gives fair agreement to rocks and soils whereas only little agreement is given by this analysis.Both agree that the units,animals,and clothing deserve but slight importance.There are some units in this analysis not mentioned by Davis: i.e. how we can keep in good physical condtion,protection from infectious diseases,communication,transportation,inter-dependence of living things,importance of matter,place and time,first aid,and mirco-organisms.

Perhaps the best conclusions that might be drawn from this comparison of topics would be for those curriculum makers in search of the subject matter of general science who are in doubt about the advisibility of adopting certain topics to accept the topics which both analyses mention as having high and fair agreement and localize their courses around these topics.

Perhaps it would not be amiss for curriculum makers to include as a bit of experimentation those topics mentioned by this analysis and ignored by Davis's for their introduction into general science between the time of both analyses might indicate a goal toward which general science is moving.

The demonstration method seems to be superior to the individual method, in respect to saving time and money, obtaining better results in the use of tests and exercises, when complex apparatus is used or a complex procedure is followed, and when dangerous experiments are performed.

The individual method seems to be superior when college entrance requirements are to be met, in experiments involving familiar apparatus and easy method of procedure, and where manipulatory skill, laboratory technique, and habits are desirable.

However, each method offers certain knowledges, skills, and habits not offered by the other.

It seems as though the demonstration method of laboratory procedure has a slight advantage over the laboratory method of individual procedure. Thus, it would seem that the better way of conducting laboratory would be by the demonstration method but occasionally allowing the pupils to use the individual method when circumstances and conditions permit.

The individual method could be used to good advantage in those experiments which are not so technical but that they might be done at home, such as the tests for starch, fats, and water, the preparation of nitrogen (by burning the oxygen out of a containter), the study of its properties, etc.

Any administrator in doubt as to whether or not to include general science in the curriculum or, if it already has its place in the curriculum, to change it to a constant instead of a variable subject may set his mind at ease by observing the following values of general science.

1. It furnishes usable knowledge to the pupil who leaves school early.

2. It furnishes a fundamental foundation for the special sciences.

3. Those who have had general science show a definite gain in physics and chemistry.

4. It arouses interest in science and in the environment.

5. It helps in the health of the student, family, and community.

6. It serves the purpose of exploration in science.

7. It helps in the choice of vocations.

8. It interprets home and social environment.

9. It has a special appeal to adolescent boys and girls, helping them to cope with the material world about them.

10. In the study of general science, fields of reading, work, and study are discovered.

11. It teaches the scientific method of thinking.

12. It prevents gullibility.

13. It teaches useful methods of solving problems.
14. It stimulates the pupil to more direct and purposeful activities and lead to a higher appreciation of the pleasure and profit to be obtained by the exercise of the pupil's abilities.
15. It gives the pupil control of a large body of facts and principles significant in the home, school, and community.
16. It has a cultural and aesthetic value.

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