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Grade placement of units in general science.

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GRADE PLACEMENT OF UNITS IN GENERAL SCIENCE

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by

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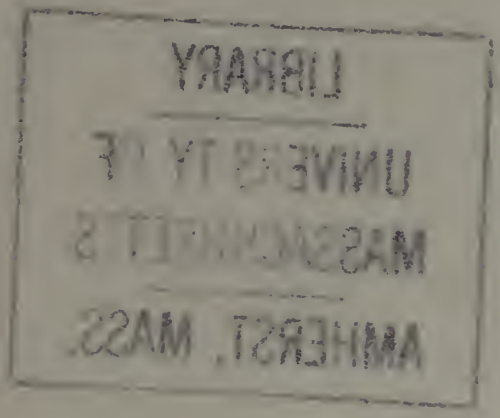

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ACKNOWLEDGMENT

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INTRODUCTION

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CHAPTER I

Introduction

(1) General historical background -- The teaching of science in the American system of education made its appearance around 1800 when several of the larger academies offered science in the form of natural history. From its inauguration, the new subject evolved through many forms and concepts and finally became an integral part of common education as biology, chemistry or physics in the high school. As these subjects grew in popularity there was felt a need for an introductory course in science which would provide a background for them. From this need there resulted another new subject, General Science, which first appeared between the years of 1910 and 1920. Between 1920 and 1930 there was a marked rise and elaboration of the General Science course, and it began to be offered in the ninth grade. With the great development of the junior high school movement, when the plan called for the 6-3-3 method of school organization, biology, chemistry and physics became the standard science courses of the three year high school and general science was then placed in the last year of the junior high school.(1)

(2) Early aims of general science -- It is interesting to contrast the aims of the infant subject and those of its more mature form. No doubt the objectives which were formulated

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(1) Hunter, G. W., Science Teaching in Junior and Senior High School Levels; Chapter 1.

earlier resulted from the acceptance of older learning products of the advanced sciences. Also teachers trained and experienced in the special sciences and the psychological theory of formal discipline may have had difficulty in comprehending clearly and advancing efficiently the claims of the new material in the terms of the newer philosophy of education. At any rate, these were the aims advanced for the study:

(a) to prepare for later study of special sciences;
(b) to acquire a fund of information about nature and the sciences;
(c) to develop observation, discrimination, imagination, and accuracy of thought.(2)

(3) Early science curricula and texts -- At its conception, general science consisted of several unrelated topics and experiments outlined by the biology, chemistry and physics teachers fundamentally for an introduction to the higher sciences. Since few publications had made their appearance at this time regarding the development of the general science curriculum, the teachers constructed what they thought should be included in an introduction. Consequently content matter of the new course was widely varied. The early science texts were very similar. Written quickly to supply a need, the books covered a wide sampling of science topics, not logically arranged, but merely a brief introduction of those topics which the author's experience and slant made him believe were a basis for the special sciences.(3)

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(2) Pieper, C. J., Science in the Seventh, Eighth, and Ninth Grades; p. 196.

(3) Hunter, G. W., Science Teaching at Junior and Senior High School Levels; p. 37.

(4) Change in emphasis -- Dissatisfaction with the subject matter offered upon the part of the pupils, the high pupil mortality of science enrolments in later grades, and the combined action of the parents and the press, resulted in an awakening of authors, teachers, and curriculum committees. They became conscious of the fact that general science should not be in preparation for a high school college course alone, but should be of a type that would prepare for life activities.(4) The realization by the public and pupils of the important role science plays in everyday life forced educational leaders to revise their views on aims, method and content of general science courses.

(5) Change in aims -- Around that time Briggs advanced his famous aims for the junior high school, three of which show the new emphasis which the public desired:

(a) to find out and satisfy the needs of the pupils;
(b) to explore the interests, aptitudes and capacities of the pupils;
(c) to reveal to the pupils possibilities in the major fields of learning.(5)

Soon after, Davis (6) made similar proposals. Speaking specifically about science, Van Denburg declared (7) that we should teach science "-----because our children need to know the ways

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(4) Hunter, G. W., "Is There Sequence in Secondary School Science?" School and Society; XX (June, 1924); pp. 316-327.

(5) Briggs, T. H., The Junior High School; p. 26

(6) Davis, C. O., Junior High School Education; Chap. IV.

(7) Van Denburg, J., The Junior High School Idea; p. 165.

Science helps them to live in the fullest extent." Talking at some length about the old aims of general science versus the new, Hines expounded three needs for general science in the junior high school in these statements:

> (a) An introductory course (in general science) is needed that not only will explain the natural phenomena but will lay the foundations for further scientific study.
>
> (b) There is a need for a pupil to gain a knowledge of science in some place besides enrolling in a laboratory class in a unit course.
>
> (c) There is a need for a course in science that will relate natural phenomena to the activities of life as the child will later find them. (8)

The decided change in emphasis is noticed in these needs for the science curriculum advanced by Bode in his discussion of the curricula of modern time and the future:

> (a) a greater working knowledge of science and its application to the solution of daily life problems with special reference to health, safety, economics, eugenics, and euthenics;
>
> (b) greater working knowledge of the facts, forces, and relationships of social life;
>
> (c) greater participation in individual and group responsibilities for selection, planning, or executing home, school, and community enterprises;
>
> (d) a greater working knowledge of the facts, problems and methods of consumer functions with reference to health, economic, aesthetic, and social values.(9)

Continuing, he stresses the fact that science should occupy a more important place in the junior high school curriculum inte-

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(8) Hines, H. C., Junior High School Curricula; Chap. XV.

(9) Bode, B. H., "The Most Outstanding Next Steps for Curriculum Workers in the United States." Teachers College Record December, 1928.

grated more closely with history, social studies, and health education.

Summarizing these citations, then, it is found that modern general science aims are quite different from those stated previously. According to the authorities whose statements were mentioned above, general science courses should offer subject matter which will:

(a) explain the immediate environment to the children;
(b) induce civic and social consciousness;
(c) induce improvement of home and community conditions;
(d) produce clear, logical thinking;
(e) educate for sensible and healthful living;
(f) educate for full use of leisure;
(g) educate for parenthood;
(h) provide possibilities for the selection of future courses in science and life work.

(6) Change in method -- With the shift in emphasis there also developed a change in the method in instruction. In the beginning the teaching of science was accomplished in much the same manner as were the other subjects of the curriculum. Either the textbook was drilled, facts, principles and all, into rather bewildered youngsters; or the facts, principles, and all were forced upon the children by way of lectures.(10) Discussing the older methods of science instruction, Pieper, and the rest of the committee (11), strongly condemn them as harmful to the study of the subject. Their opinion, which follows the trend of many of our outstanding educators, is quoted here:

Science is essentially an experimental study of materials

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(10) Hunter, G. W., Science Teaching at Junior and Senior High School Levels; pp. 162 and 165.

(11) Pieper, C. J., Science in the Seventh, Eighth, and Ninth Grades; National Society for the Study of Ed.; 31st Yearbook; Part 1; p. 213.

and phenomena and requires, therefore, learning activities that are designed to solve problems relating to concrete and objective instructional materials, whether in pure science or in its applied aspects.

Science taught in the old logical method was greatly responsible for the dissatisfaction causing the awakening of public and educational leaders discussed previously. Through interest studies, discussions with pupils, and various other methods of contact with children, experimentors all came to one conclusion--science lends itself best to the psychological approach in teaching.

a. Activities -- In their everyday life, children react to their environment and whatever phases of science knowledge and material which they experience by certain activities. Bringing life to the classroom, education has evolved into a series of physical and mental activities chosen and arranged to interest and orient the child in the unit in progress. So it is with science teaching--not the old textbook or lecture methods, but a well directed objective series of activities and experiences provides a firm psychological method of approach and instruction.

b. Listing and classification of activities --

These activities fall into three classifications:

(a) those designed for the purpose of gaining new abilities, new skills, new knowledges, new interests, and new attitudes;
(b) those designed to give practice in the use of abilities previously gained;
(c) those designed to give the pupil means of measuring his acquisition of the learning products sought.(12)

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(12) Pieper, C. J., The Seventh, Eighth and Ninth Grades; National Society for the Study of Education; 31st Yearbook; Part 1; p. 214.

Pieper lists forty-four activities which have proven in practice to be worthwhile and valuable.(13) These, well chosen and well directed, take the "busy work", aimless activity, and memory and drill of detailed facts from science class, replacing them with inspired interest and soulful satisfaction. In addition, provisions can easily be made to care for individual differences in the capacities and interests of the children.

With activity as the basis, three well known plans are being used extensively in science teaching: The Problem Method (14), The Project Method (15, 16), and The Morrison Plan (17). There are many more methods used in providing interesting experiences for the children. Those which have proven of value are: demonstrations, class experiments, field and museum trips, and instruction by the use of visual materials. All of these are relatively new methods and they indicate the change which has taken place in science teaching.

(7) Change in content -- The content matter of a science curriculum is more or less tied up with its aims and emphasis. With the change in objectives of junior high school

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(13) Op. cit. pp. 214-216.

(14) Dewey, J., Democracy and Education; Chapter II.

(15) Kilpatrick, W. H., "Project Teaching"; General Science Quarterly; Volume I (February, 1917); pp. 48-51.

(16) Watkins, R. K., "Technique and Value of Project Teaching in General Science"; General Science Quarterly; Volume VII; (November, 1923); pp. 116-123.

(17) Hunter, G. W., Science Teaching at Junior and Senior High School Levels; p. 183.

science there also developed a change in the subject matter to conform to the new objectives. Content of a course which adheres to the list of aims stated above would necessarily have to touch upon a wide range of science units. A glance at current science texts and curricula would clearly demonstrate the scope of general science as taught today. There is a decided lack of unanimity in the content of junior high school science. However, there is a fairly logical reason for this lack of unison. Pieper declares in his report (17) that subject matter should deal with activities and problems interesting to the child and which form part of his experiences. The emphasis, in his committee's opinion, should be placed on practical adjustments to environment by means of activities that are based on direct and concrete experiences. Hunter (18) concurs with these words:

> -----It would seem that the underlying philosophy of the course should be based on the relationship of the environment to the child; first as an individual and later as a growing citizen in the environment of the school and community. In such a course the materials of science should be integrated with the curricula materials of geography, history, civics, and especially health education.

Thus, it may be seen, from these sources, that subject matter in separate communities may, through environmental factors, lack unanimity as a logical result.

(8) Trend to lower grade levels -- The recognition of science as a major factor in modern life prompted changes not only in emphasis, methods, and content, but also in the number

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(17) Op. cit.

(18) Hunter, G. W., & Whitman, J. R., Problems in General Science; Foreword to Teachers.

of years science should be offered in junior high schools. When first introduced, general science was placed into the ninth grade where it remained for a number of years. The Committee of Reorganization of Science (19) in 1920 recommended a rather radical departure from that program by suggesting that general science should not only be taught in the ninth grade, but should be placed in the seventh and eighth grades of the junior high school in addition. The program outlined by Powers and his committee (20) in 1932 suggested that general science be offered three periods a week, in grades seven and eight, and five periods a week in grade nine. Following the suggestions of these reports science courses were revised in a large number of communities. There is still a tendency for a downward growth through the junior high school into the elementary grades.

(9) Placement of content -- The introduction of science into grades seven and eight, the new philosophy of education, and the large mass of science material now available, has created a dilemma for educators to solve--that of placing subject matter in a specific grade to produce the most efficient results. The first attempt to suggest a sequence was the report of the Commission on the Reorganization of Secondary Education (21) which suggested the following program:

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(19) Reorganization of Science in Secondary Schools.

(20) Powers, S. R., The Plan of the Public Schools and the Program of Science Teaching.

(21) Reorganization of Science in Secondary Schools.

Seventh or Eighth Year:

Five periods a week; or both years with three periods a week. Content--general science including hygiene.

Ninth Year:

Five periods a week. Content--biological science including hygiene; courses may consist of general biology, botany, or zoology.

The Department of Superintendents' fifth yearbook (22) offered the following sequence: biological material in the seventh grade; health materials in the eighth, and physical science in the ninth year. Cox (23), however, derided this offering by remarking that the child didn't live in a biological world in the seventh grade, in a health world in his eighth, and in a world of physical science during his ninth year, but he did live in a world of things, phenomena, forces and people all the time. No other reports could be found which would comment specifically on the placement of subject matter into certain grades. This is no doubt due to the belief that science courses should interpret the immediate environment of the child. From a survey of various science courses there may be found a fair correlation of subject matter in grade nine but a wide divergence noticed in grades seven and eight.

(10) How to discover content and placement -- If one

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(22) National Education Society; Department of Superintendents; Fifth Yearbook; 1927.

(23) Cox, P. W., The Junior High School Curriculum; Chapter II.

wished to discover what materials were offered in general science and their placement in the junior high schools, he could follow several procedures. First, he could collect all the courses of study in a given region and from those determine by means of tabulation what the majority of communities offered in each grade. Second, he could review all the current textbooks in the same region and follow much the same procedure as the first. Grade placement in this type of survey may be difficult as many of the texts give no suggestions in regard to grading. Third, he could make a check-list questionnaire, in itself a tabulation of subject matter offered in several texts and science courses, and send these to teachers of science in the junior high schools of the region asking their cooperation in checking the work taught and its grade placement. With these returned, the student could determine fairly accurately (providing enough questionnaires are returned) the content and grade placement. These could be tabulated with greater ease and efficiency.

The method of determining what units were taught in general science was used in this study. A check-list questionnaire was prepared and sent to all the towns and cities maintaining junior high schools. The returns from these communities forms the basis of the following study.

RELATED LITERATURE

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Chapter II

Related Literature

A great deal has been written and several studies made in regard to content matter in science courses. These have been written and studied from a variety of views and philosophies. Most of the studies and writings, however, are for the determination of objectives, for when these are found, subject content can be matched to them in sequence.

(1) Discovery of content through principles and objectives -- Selecting his material from the volumes of Nature Study Review, courses of study in elementary science work, literature on science teaching, and the works of specialists in the major science fields, Craig (1) compiled a list of statements to be used as guides in selecting objectives of science for elementary schools. Submitting these to nearly 200 educated people, he asked them to rank them according to what they thought were their importance. From the returns, Craig determined the order of ranking. Going still further, he evaluated the order by the questions submitted by 7000 school children in grades one to eight. Downing (2), with the aid of several students, determined the principles a course of science should develop from the study of twenty text books in general science published between the

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(1) Craig, G. S., "Certain Techniques used in Developing a Course of Study in Science for the Horace Mann School"; Teachers College, Columbia Univ., Contrib. to Ed.; No.276;1927; pp.12 & 13.

(2) Downing, E. R., "An Analysis of Textbooks in General Science"; General Science Quarterly; 12 (May 1928); pp. 509-516.

years of 1915 and 1927. In his investigation of the aims of authors of general science texts, Klapp (3) discovered that although the authors failed to agree on the type and amount of subject matter, there was a fair degree of agreement upon the major objectives of the study.

(2) Discovery of content through study of textbooks -- Several studies have been carried on to determine the content of a general science course through the review of the current textbooks on that subject. By making an analysis of fourteen science texts then in use, Weckel (4) found some agreement on the larger topics of study and from this received a basis for a standardized course of study. Attacking the problem from another point of view, Meier (5) examined the exercises presented in the more popular texts and laboratory manuals. Submitting the result of her study to seventh and eighth grade teachers over a wide area, she discovered that the majority of them favored the applied science type of exercise rather than the pure science type. A more recent study by Davis (6) following a similar procedure to that of Weckel, revealed that during the past few years

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(3) Klapp, W. J., "A Study of the Offerings of General Science Texts"; General Science Quarterly; Volume XI (May, 1927); pp. 507-512.

(4) Weckel, A. L., "Are Principles of Organization of General Science Evidenced in the Present Textbooks?" School Science And Mathematics; Volume XXII (January, 1922); pp. 44-51.

(5) Meier, L., "Current Practices in the Teaching of Science in the Seventh and Eighth Grades"; General Science Quarterly; Volume VIII (November, 1924); pp. 1-7.

(6) Davis, I. C., "Analysis of the Subject Matter in the Eight Most Widely Used Textbooks in General Science"; School Science and Mathematics; Volume XXXI (June, 1931); pp. 389-396.

authors of science texts, on the whole, have come to a better agreement of basic subject matter.

(3) Discovery of content through interest studies -- Perhaps some of the most weighted discoveries in regard to content matter have come about through the study of the interests of children. The change of educational philosophy during the present period to the centering of school activities around the interest of the child has attracted the attention of authors, teachers, and curriculum committees. Finley (7) was one of the earlier investigators along that line. Working with children, he discovered that their interest was greater in regard to animal life than to plant or physical science. Adopting a similar technique, Curtis (8) found that the questions asked by the children regarding aspects of their environment had a great amount of weight when discussions centered around the science syllabus. Many other studies were made along this line and their findings are listed by Hunter in his text (9).

(4) Discovery of content through the study of periodicals.-- Some ideas regarding the content of a general science course can be obtained by the comparison of science articles in magazines and the textbooks in use. Although the studies men-

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(7) Finley, C. W., "Some Studies of Children's Interest in Science Materials"; School Science and Mathematics; Volume XXI (January, 1921); pp. 12-18.

(8) Curtis, F. D., "Some Values Derived from Extensive Reading in General Science"; Teachers College, Columbia Univ. Contrib. to Ed.; No. 163; 1924.

(9) Hunter, G. W., Science Teaching at Junior and Senior High School Levels; pp. 64-96.

tioned below do not deal specifically with general science, they are noted because of their possibilities. Because they do reach a large cross-section of the public there should be a high correlation between everyday readings and materials offered in the schools. In his investigation, Hopkins (10) declares that biology occurred with the greatest frequency although science articles were fairly well distributed in papers and magazines. As a consequence, it is his assumption that to meet this condition biology should be offered in those grades where the greatest number of people may be reached. Searles and Ruch (11) at the conclusion of their summary of science articles from leading periodicals were in accordance with Hopkins.

(5) Discovery of content through the study of curricula -- Using the results of five curriculum studies, the analyses of five textbooks, and the topics included in eleven courses of study, Harap and Persing (12) evaluated the combination and produced a list of 275 subject matter objectives each with their relative values. Going deeper into this type of work, Cureton (13) analyzed previous investigations and combined his findings

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(10) Hopkins, L. T., "A Study of Magazine and Newspaper Articles with Relation to Courses in Science for High School"; School Science and Mathematics; Vol. XXV (March, 1925);pp.125-133.

(11) Searles, A. H. and Ruch, G. M., "A Study of Science Articles in Magazines"; School Science and Mathematics; Vol. XXVI (April, 1926); pp. 273-290.

(12) Harap, H. and Persing, E. C., "The Present Objectives in General Science"; Science Education; Volume XIV (March, 1930); pp. 477-497.

(13) Cureton, E. E., "Junior High School Science"; Science Education; Volume XIV (December, 1927); pp. 767-775.

with the topics of nine courses of study, the results of several standard tests, and thirty-six texts and manuals in general science. From this synthesis he obtained 548 topics and problems, 245 of which he announced as being most important through further study. Curtis (14) made an elaborate study of three courses of study considered to be outstanding--namely, those of Denver, Detroit, and New York state, and combined his findings with those he obtained from an abstract of fifteen analyses of materials appropriate for inclusion in a course of general science. This work netted him a list of 1850 topics which he evaluated through statistical treatment. Teachers College at Columbia University, it was discovered, completed an evaluation of science curricula of over 400 junior high schools and ranked those of outstanding merit. The course of nature study and general science offered in the junior high schools of Springfield, Massachusetts, was included in the first ten in rank.(15)

The present study is an attempt to make the picture more complete so far as Massachusetts is concerned by analyzing what is being taught in general science and the grade in which it is being taught.

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(14) Curtis, F. D., A Synthesis and Evaluation of Subject-Matter Topics in General Science.

(15) Hunter, G. W., Science Teaching at Junior and Senior High School Level; p. 136.

STATEMENT OF PROBLEM AND SUMMARY OF PROCEDURE

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Chapter III

Statement of Problem and Summary of Procedure

The specific problem in this study is as follows:

(1) The problem -- To discover and analyze the subject matter units which are being taught in Junior High School General Science and to evaluate these units as a basis for a General Science Course to be used in Burlington, Massachusetts.

(2) Subjects and materials -- A check-list questionnaire was decided upon as the best means of contacting the 114 communities maintaining junior high schools in the state. This was sent to 169 supervisors, principals, and teachers of science with directions as to checking along with a letter requesting the cooperation of the subjects and offering to return the results of the investigation if so desired. To produce better returns, stamped envelopes were included in the letters, and in communities which could be reached easily personal visits were made to those who were slow in returning the desired information. From the number of letters sent, 106 communications were received resulting in the contact with 86 different communities, a return amounting to 75.4 per cent.

(3) Procedure -- The general procedure in the study was as follows:

(a) Preparation of check-list -- In order to construct the check-list, many old as well as current general science texts were reviewed and combined with the findings from studies of science curricula from many states and cities of the country.

These were organized into subject units under the main fields of science taught in the schools. To provide for additional units which might occur, blank spaces were included at the end of each section. Columns were made to the left of the units for the purpose of checking the grade in which the unit was taught.

(b) Administering the questionnaire -- To check the questionnaire, it was requested that a check be placed in the column entitled "Taught", and the grade number in the column entitled "Grade", if a unit in the list were taught in a particular school,course, or system. (See sample of check-list in appendix)

(c) Tabulation of results -- As the information was received the results were classified according to grades. When this procedure was concluded, the percentage of response of each unit in specific grades was calculated by finding the number of returns there were for each grade, then dividing than number (55 in grade seven; 72 in grade eight; 66 in grade nine) into the number of responses each unit received by grades. Upon the determination of the percentage of response, the critical ratio of the difference was computed for each item in combinations by the statistical treatment outlined in Chapter IV and in Index II. A critical ratio of 3 or more indicated whether the item should be taught in grade eight or nine. Any items below that ratio were placed in grade seven. A discussion and grade listing follows each table showing the percentages of response and the critical ratio for particular subject fields.

(d) From the results tabulated and discussed previously, a summary was drawn up showing the possibilities and limitations of the study.

(e) The summary showed a lack of unity in regard to a standard course of science for the state. This brought about certain implications which were discussed in the final chapter.

TABULATION AND DISCUSSION OF DATA

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Chapter IV

Tabulation and Discussion of Data

The results of the checking of the list are found in this chapter. It was thought that the results would be clearer to the reader if the general organization of the check-list were followed. This has been done in the following pages under appropriate headings.

(1) Discussion of returns of check-list -- Although a program of junior high school science encompassing grades seven, eight, and nine was suggested as the most feasible and modern by the Committee of Reorganization of Science (1), again by Powers and his committee (2) in 1932, and by many of the leading educational authorities, the returns showed that many of the junior high schools in Massachusetts are not in accord with the suggestions. From the 86 communities reporting, the information list in Table I was accumulated.

Table I

Grades in Which Science is Taught in 86 Massachusetts Junior High Schools

Grades Taught	Number of Schools
7 (only)	1
8 (only)	4
9 (only)	13
7 and 8	15
8 and 9	14
7, 8, and 9	39
Total	86

(1) Reorganization of Science in Secondary Schools; U. S. Bureau of Ed. Bull. 26; 1920;

(2) Powers, S. R., National Society for the Study of Ed.; 31st Yearbook; 1932; Chapter 1.

A few additional units were suggested by the subjects but on the whole the questionnaire seemed to be fairly complete. In one section, however, entitled physiology, two rather important subject units were overlooked, but those checking the list seemed to notice no discrepancy as the number who did write them in as taught in their school was exceedingly small.

Included in the questionnaire were two questions: one, regarding guidance for future courses in specialized sciences, and the other regarding the use of marks in determining whether students should take future courses in science. The first question will be dealt with in the data relating to the teaching of science units. The other, since no provisions were made to deal with the results by grades, will be noted here. Twenty-six of the schools contacted declared emphatically that marks were not the determining factor regarding the selection of future courses of science. Twelve declared that marks were used in judging whether a child should continue work in science. Eleven said that marks were used partly for determination of a child's choice and six stated that interest and aptitudes were used by them as a basis of guiding a pupil's future selections.

(2) Analysis of check-list items -- The "percentage of response" will be shown by tables indicating the percentage of item by grades. To determine these calculations, the number of schools offering science in grade seven was found from Table I (55) The percent was figured by dividing the checks each unit received in grade seven by 55 and its percentage of response was revealed. The same procedure was followed for grade eight (72

schools) and grade nine (66 schools). The second step in the analysis was to compute the standard error of each percentage by means of the formula $\sigma_P = \sqrt{\frac{Pq}{N}}$, where P is the percentage, q its complement, and N the number of schools. Step three was to compute the standard error of the difference between each combination (7 vs. 8, 7 vs. 9, and 8 vs. 9) of percentages using the formula $\sigma_{dp} = \sqrt{\sigma_{p_7}^2 + \sigma_{p_8}^2}$ where $\sigma_{p_7}^2$ is the standard error of grade seven percentage squared, and $\sigma_{p_8}^2$ is the standard error of grade eight percentage squared. The fourth step was to compute the ratio $\frac{D}{\sigma_d}$ (sometimes called the "critical ratio"), where D is the difference between the two percentages and σ_d the standard error of that difference. For an example of the full computation, see appendix II.

As pointed out in Chapter III, the reason for this procedure was the fact that this study was not so much interested in the absolute size of the percentages as in their relative size. Is there a significant difference between the percentages of teachers who think an item should be in grade seven and those who think it should be in grade eight? By convention, a critical ratio of 3.0 or more is taken to indicate a significant difference in response. Using the above procedure, the analysis of the check-list would be as follows.

(3) Results in astronomy -- Table II shows the result of the computations for the section dealing with astronomy. The absolute size of the percentages of response for the last

Table II

The Percentage of Response for the Several Items in Astronomy Together with the Critical Ratio of Difference

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
The solar system.....	23.0	49.0	51.0	3.2	3.3	0.2
The sun and its influence.....	29.0	48.0	49.0	2.2	2.3	0.2
The starry or sidereal system	11.0	38.0	36.0	3.8	3.4	0.2
The constellations.....	20.0	52.0	45.0	4.0	3.0	0.8
The moon and its influence....	16.0	52.0	51.0	4.7	4.4	0.1
Movements of the earth and their results.....	20.0	50.0	49.0	3.7	3.7	0.0
Theories of the earth's origin	16.0	29.0	43.0	1.8	3.5	1.8
Ancient beliefs about the stars and the earth.....	18.0	35.0	35.0	2.2	2.1	0.0
Telling time by the heavenly bodies.....	5.0	1.0	2.0	1.2	0.9	0.1
Comets and meteors.....	0.0	0.0	2.0	0.0	0.0	0.0
Number answering.....	55	72	66			

two items would indicate that teachers are agreed that these items should not be taught in junior high school. Referring to the ratios in the last three columns, the following conclusions may be made: (a) The item "The solar system", according to the teachers, should not be taught in grade seven. The difference between the percentages of response (23 and 49) for grades seven and eight is significant (ratio 3.2). The fact that the ratio for grades seven and nine is also significantly large (3.3) would indicate that teachers are undecided as to whether the item should be taught in grade eight or in grade nine. (b) The item, "The sun and its influence", has no ratio as large as 3.0, and

the conclusion, therefore, would appear to be that teachers in general have no good reason for not teaching it in grade seven. (c) "Theories of the earth's origin" received a ratio of 3.5 between grades seven and nine, and 1.8 between grades eight and nine. This would indicate that teachers have agreed that it shouldn't be taught in grade seven, but in either grade eight or nine; as to which grade, they are not exactly sure.

Using this method of interpretation, the summary for Table II would indicate that teachers have placed the items as follows:

Grade 7	Grade 8 or 9
Sun and its influence.	The solar system.
Ancient beliefs about the stars and earth.	The starry or sidereal system.
	The constellations.
Grade 8	The moon and its influence.
	Movements of the earth.
None	Theories of earth's origin.

(4) Results in physiography -- The computations for this section are shown in Table III.

Table III

The Percentage of Response for the Several Items in Physiography Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Recognition of common rocks and minerals	36	18	32	2.3	0.4	1.9
Earth formations	27	27	35	0.0	1.0	1.0
Changes in the earth's surface	32	28	38	0.5	0.5	0.0
Earth materials and their uses to man	27	32	38	0.6	1.3	0.7
Soils and their uses	29	25	41	0.5	1.4	2.0
Geology of the region	16	14	17	0.3	0.2	0.5

In Table III none of the percentages of response show a critical ratio of difference as large as 3.0. The conclusion seems evident that the teachers could see no reason why all of the items under Physiography should not be taught in grade seven. The tabular arrangement for this section is as follows:

Grade 7
Recognition of common rocks and minerals.
Earth formations.
Changes in the earth's surface.
Earth materials and their uses to man.
Soils and their uses.
Geology of the region.

(5) Results in Weather -- Table IV displays the computations resulting in this section:

Table IV

The Percentages of Response for the Several Items in Weather Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Temperature.....	31	52	50	2.4	2.1	0.2
Air pressure.....	29	53	51	2.7	2.5	0.2
Winds and air currents.....	25	48	56	2.7	3.7	0.9
Storms.....	18	45	42	3.4	2.8	0.3
Cloud formations.....	18	42	44	3.1	3.3	0.2
Weather forecasting.....	22	42	48	2.5	3.1	0.7

Following the above procedure, since the critical ratios for "Temperature" are all below 3.0, this item is placed under grade seven. So, also, is the second item, "Air pressure". Teachers are not decided as to whether "Winds and air currents" should be in grade seven or eight (C.R. 2.7) or between eight or nine (C. R. 0.9), but the conclusion is evident that they would prefer

eight or nine to seven. The tabular arrangement would be:

Grade 7	Grade 8	Grade 8 or 9
Temperature Air Pressure	Storms	Cloud formations Winds and air currents Weather forecasting

(6) Results in Energy and Machines -- A decided trend toward grade nine is shown in Table V.

Table V

The Percentages of Response for the Several Items in Energy and Machines, Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Fire	29	34	59	0.7	3.3	2.9
Heat	22	34	68	1.5	5.7	4.2
Sound	4	24	68	3.2	11.0	5.5
Light	7	31	72	3.5	9.5	5.1
Primary machines	0	14	72	3.3	12.1	8.4
Steam engine	2	13	63	2.2	9.5	6.9
Water power	11	21	60	1.4	6.4	5.0
Windmill	11	11	29	0.0	2.5	2.6
Gas engine	0	8	77	2.1	14.5	11.3
Electricity	5	18	66	2.2	8.8	6.4
Transmission of power	2	8	66	1.5	10.3	8.7
Magnetism	9	24	69	2.2	8.6	5.9
Diesel engines	0	0	2	-	-	-

Here we see a decided concensus of opinion toward the placing of all of the items listed in grade nine. Only one, "Windmills", received a ratio of less than 3, which would place it into grade seven. "Sound", "Light", and "Primary machines" received ratios of over three when the differences between grades seven and eight were compared. Ordinarily, this would designate the placement of the items in grade eight, however, when the critical ratio of difference between grades eight and nine, and seven and nine,

were computed, the much larger ratios undeniably placed them in grade nine. From this, then, we would designate grade placement as follows:

Grade 7	Grade 9
Windmill	Fire
	Heat
	Sound
	Light
	Primary machines
	Steam engine
	Water power
	Gas engine
	Electricity
	Transmission of power
	Magnetism

(7) Results in Industry -- In Table VI are shown the results of computations of the items in industry.

Table VI

The Percentages of Response for the Several Items in Industry Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Types of industry.....	4	7	18	0.8	2.5	1.9
Study of local industries.....	4	6	18	0.6	2.5	2.1
Factors determining location..	4	6	13	0.6	1.8	1.4
Sources of power.....	5	11	24	1.2	3.1	1.9
Science in industry.....	4	6	29	0.6	4.1	3.7
Industrial diseases and control	5	6	14	0.2	1.7	1.5
Safety in industry.....	11	8	23	0.5	1.8	2.5

As the critical ratio in items "Types of industry", "Study of local industries", and "Factors determining location" is less than three, these would be placed in grade seven. So also would "Industrial diseases and control" and "Safety in industry". In the comparison of percentages between grades seven and nine,

"Sources of power" is relegated to grade nine because of the ratio of 3.1. The ratio of 4.1 between grades seven and nine, and 3.7 between grades eight and nine, would seem an indication to place "Science in industry" in grade nine. The result of these comparisons would give the placement of these items as follows:

Grade 7	Grade 9
Types of industry	Science in industry
Study of local industry	
Factors determining location	
Industrial diseases and their control	Grade 8 or 9
Safety in industry	Sources of power

(8) Results in Transportation -- A decided trend toward grade nine is shown in Table VII.

Table VII

The Percentages of Response for the Several Items in Transportation, Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Early forms.....	18	17	48	0.1	3.7	4.1
Railroad.....	11	21	47	1.5	4.0	3.3
Transportation by water.....	16	17	50	0.1	4.3	4.4
Automobile.....	7	17	53	1.8	5.1	4.8
Airplane.....	13	18	53	0.7	5.2	4.5
Safe driving.....	11	14	45	0.5	4.5	4.2

In computing the critical ratio of difference between grades seven and eight, the results in all the items were below 3, thereby removing these from grade eight. However, when the same procedure was followed between grades seven and nine, and eight and

nine, in all cases the results were well above 3. From this the conclusion is drawn that all of the items should be placed in grade nine.

Grade 9

Early forms of transportation
Railroad
Transportation by water
Automobile
Airplane
Safe driving

(9) Results in Communication -- A similar opinion is regard to the placement of items under Communication is displayed in Table VIII.

Table VIII

The Percentage of Response for the Several Items in Communication, Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Early forms.....	11	17	57	0.9	6.2	5.3
Telegraph.....	9	18	67	1.5	8.4	6.7
Telephone.....	9	18	67	1.5	8.4	6.7
Wireless.....	9	17	59	1.3	6.9	5.6
Radio.....	9	17	62	1.3	7.4	6.0
Television.....	6	13	40	1.1	4.7	3.7

As in the previous section, the ratio between grades seven and eight in all items is less than 3. Between grades seven and nine, and eight and nine, the ratios are well above 3, indicating that these items should be placed in grade nine. Placement is shown by the following list:

Grade 9

Early forms of communication
Telegraph
Telephone
Wireless
Radio
Television

(10) Results in Community --Table IX indicates the choice of the teachers in Community items.

Table IX

The Percentages of Response for the Several Items in Community Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	7 vs. 9
Water supply.....	29	48	56	2.2	3.1	0.9
Sewage disposal.....	18	35	56	2.2	4.7	2.5
Building of streets and roads.	13	14	35	0.1	3.0	3.0
Protection from fire.....	34	25	53	1.1	2.1	3.5
Protection from disease.....	36	29	57	0.8	2.3	3.4
Parks and their use.....	14	11	21	0.5	1.9	2.5
Public service departments....	11	11	32	0.0	3.0	3.0
Community planning and zoning	7	4	27	7.0	3.1	3.8
Garbage disposal.....	0	4	0	-	-	-

By virtue of the computations, the opinion of the teachers seems to ignore grade eight. "Parks and their uses" did not receive a critical ratio in any of the comparisons, thereby placing it in grade seven. When the ratios between grades seven and nine was revealed, "Water supply" and "Sewage disposal" seemed designated for grade nine. In the comparison between grades eight and nine, "Protection from fire" and "Protection from disease" seemed most logically placed in grade nine. Three items,

"Building of streets and roads", "Public service departments", and "Community planning and zoning" are also placed in grade nine as the comparisons between grades seven and nine, and eight and nine, in these items are both above 3 in ratio. Therefore the placement of the topics under this section would be:

Grade 7

Parks and their use

Grade 8 or 9

Water supply
Sewage disposal

Grade 9

Building of streets and roads
Protection from fire
Protection from disease
Public service departments
Community planning and zoning.

(11) The Results in Homes and Buildings -- The percentages of response and the critical ratio of the items under Homes and Buildings are listed in Table X.

Table X

The Percentages of Response for the Several Items in Homes and Buildings, Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Building materials.....	9	14	35	0.8	3.7	2.9
Types of buildings.....	5	8	30	0.7	3.9	3.4
Construction.....	2	7	24	1.4	4.0	2.3
Water supplies.....	16	25	45	1.2	3.7	2.4
Lighting in the home.....	11	20	62	1.4	7.0	5.5
Heating and ventilation.....	20	31	64	1.1	5.5	4.1
Modern conveniences.....	9	14	41	0.8	4.4	3.7

From this table we see that the cooperating teachers believe that this material is best taught in grade nine. When the ratio between grades seven and eight was computed, it was found to be less than 3, and therefore unreliable. However, when the same

was done between grades seven and nine, and eight and nine, the results were all above 3, making the selection of all the items for grade nine reliable. Grade placement follows.

Grade 9	Grade 8 or 9
Building materials	Construction
Types of buildings	Water supplies
Lighting in the home	
Heating and ventilation	
Modern conveniences	

(12) The Results in Science in Society -- a better dispersement of the items in this section is noticed in Table XI.

Table XI

The Percentages of Response for the Several Items in Science in Society, Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Modern explorations.....	9	15	24	0.9	2.6	1.5
Great men of science.....	32	36	57	0.4	4.0	2.4
Musical instruments.....	7	10	38	0.6	4.7	4.0
Pictorial Art.....	2	1	8	0.4	1.5	2.0
Moving and talking photography	2	3	27	0.3	4.3	4.2
Modern architecture.....	2	0	6	-	-	-

Two items, "Modern explorations" and "Pictorial art" received ratios of less than 3. Therefore, since no good reason can be given for not doing so, they are placed in grade seven. The ratios between grades seven and eight are very small in all the items and as a result placement of any of the items in grade eight is not considered wise. The rest of the items, particularly "Moving and talking photography", by virtue of their high ratios,

are placed in grade nine. Placement by grades follows.

Grade 7

Modern exploration
Pictorial art

Grade 9

Musical instruments
Moving and talking photography

Grade 8 or 9

Great men of science

(13) The Results in Plant Life -- A swing toward grade seven is noticed in Table XII.

Table XII

The Percentages of Response for the Several Items in Plant Life Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Recognition of common trees...	32	21	15	1.4	2.2	0.9
Recognition of common shrubs..	25	14	12	1.5	1.8	0.3
Recognition of common flowers.	29	23	15	0.8	1.9	1.2
Colorless plants and their recognition.....	7	13	18	1.1	1.8	0.8
Recognition of lower green plants.....	7	10	20	0.8	2.1	1.6
Uses of trees and shrubs.....	20	18	20	0.2	-	0.3
Uses of flowers.....	7	22	27	2.5	3.1	0.6
Flower parts.....	11	30	35	2.7	3.3	0.6
Tree and shrub physiology.....	7	14	23	1.3	2.5	1.3
Garden preparation.....	11	17	20	0.9	1.4	0.4
Forests and their conservation	32	27	35	0.6	0.3	1.0
Preparation of plants for seasons.....	13	14	14	0.1	0.1	-
Importance of plants to man...	16	25	30	1.2	2.5	1.2
Work of green plants.....	0	0	2	-	-	-
Photosynthesis.....	0	0	2	-	-	-

The small percentages received by the last two items removed them from consideration. Only two items, "Uses of flowers", and "Flower parts", maintained a critical ratio of over 3. These

were computed in the comparison between grades seven and nine, thereby placing the two items in grade nine. The rest of the items, excepting the last two which are ignored, are placed in the seventh grade because neither of the other grades, in the opinion of the teachers, seems to be the place for them. Placement is as follows:

Grade 7	Grade 8 or 9
Recognition of common trees	Uses of flowers
Recognition of common shrubs	Flower parts
Recognition of common flowers	
Colorless plants and their recognition	
Recognition of lower green plants	
Uses of trees and shrubs	
Tree and shrub physiology	
Garden preparation	
Forests and their conservation	
Preparation of plants for seasons	
Importance of plants to man	

(14) Results in Animal Life -- A decided trend toward Grade seven is noticed in Table XIII.

Table XIII

The Percentage of Response for the Several Items in Animal Life Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Animals without backbones.....	7	6	23	0.2	2.5	2.9
Microscopic animals.....	9	9	35	-	3.5	3.7
Animals with backbones.....	9	7	23	1.4	2.5	2.8
Bird recognition.....	29	17	18	1.6	1.4	1.1
Bird life and migration.....	29	27	17	0.2	1.6	1.4
Insect life histories.....	16	11	29	0.8	1.7	2.5
Response of animals to the seasons.....	16	14	11	0.3	0.8	0.5
Animals useful to man.....	25	15	26	1.5	0.1	1.6
Conservation of wild life.....	27	15	23	1.8	0.5	1.2
Living things in their environment	2	0	0	-	-	-
Phyla.....	0	0	2	-	-	-
Shellfish protection.....	0	1	0	-	-	-

From the above table, we may draw several conclusions. One, "Microscopic animals" is the only item which is favored by the teachers as material for grade nine instruction. Two, while "Animals without backbones" and "Animals with backbones" are almost favored for grade nine there is still a little doubt about placing them in either grade eight or grade nine. The rest of the items, excepting the last three, are placed in grade seven. Placement follows.

Grade 7	Grade 9
Bird recognition	Microscopic animals
Bird life and migration	
Insect life histories	Grade 8 or 9
Response of animals to seasons	
Animals useful to man	Animals with backbones
Conservation of wild life	Animals without backbones

(15) Results in Physiology -- The response and calculation of this group follow in Table XIV.

Table XIV

The Percentages of Response for the Several Items in Physiology Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Sight	38	29	53	1.3	1.6	2.9
Hearing	36	25	50	1.3	1.5	3.1
Taste	36	24	38	1.4	0.2	1.8
Nutritional processes	36	27	42	1.3	0.8	1.8
Respiration	40	31	51	1.0	1.2	2.4
Waste disposal	29	27	42	0.2	1.5	1.8
Muscular system	36	25	38	1.3	0.2	1.7
Bone structure	27	27	30	-	0.3	0.4
Teeth	40	34	42	0.7	0.2	1.1
Reproductive processes	7	8	23	0.2	2.5	2.5
Human sex education	2	0	0	-	-	-
Nervous system	0	2	0	-	-	-
Circulatory system	0	0	0	-	-	-

"Sight" here has nearly a ratio of 3 when grade nine is compared with grade eight. In the other cases, the ratio is low. Another item, "Human sex education", does not show enough strength to warrant consideration about placing it in grade seven, eight, or nine. Because of its controversial nature, it would seem best to offer this unit in higher grades if offered at all. The rest of the items are low in ratio and are therefore placed in grade seven. Grade placement would be as follows:

Grade 7	Grade 9
Taste	Sight
Nutritional processes	Hearing
Respiration	
Waste disposal	
Muscular system	
Bone structure	
Teeth	
Reproductive processes	

(16) Results in Hygiene and Health -- Table XV shows the results in this section.

Table XV

The Percentages of Response for the Several Items in Hygiene and Health, Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Cleanliness habits.....	56	48	42	1.3	1.5	0.7
Care of the body and parts....	50	39	40	1.2	1.1	0.1
Effect of exercise.....	49	31	39	2.0	1.1	0.9
Effects of alcohol and tobacco	58	39	51	1.9	0.7	1.4
The air we breathe.....	56	36	48	2.2	1.3	1.4
Common diseases.....	40	39	44	2.1	0.4	0.6
Prevention of disease.....	49	41	53	0.8	0.4	1.4
Bacteria helpful to man.....	50	39	51	1.2	0.1	1.4
First aid.....	50	39	36	1.2	1.6	0.3
Planning a vacation.....	2	2	0	-	-	-
Bacteria harmful to man.....	2	0	0	-	-	-

The items in Hygiene and Health seem, logically, to fall into grade seven. In three cases, however, we might see that "Air we breathe", "Effect of exercise", and "Common diseases" show a little strength. This is not strong enough to warrant placing in grade eight. The listing for grade seven follows:

Grade 7

Cleanliness habits	The air we breathe
Care of the body and parts	Common diseases
Effect of exercise	Prevention of disease
Effect of alcohol and tobacco	Bacteria helpful to man
First aid	

(17) Results in Food and Nutrition -- Preference in regard to these items is shown in Table XVI.

Table XVI

The Percentages of Response for the Several Items in Food and Nutrition, Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Types of food.....	29	36	24	0.8	0.6	1.5
Sources of food.....	27	36	23	1.3	0.5	1.7
Uses of food.....	27	38	23	1.3	0.5	1.9
Food values.....	23	35	20	1.5	0.4	2.0
Selection of foods.....	22	35	18	1.6	0.5	2.3
Model meals.....	18	28	15	1.3	0.4	1.0
Preservation of foods.....	14	31	13	2.3	0.3	2.8
Food advertising.....	9	17	6	1.3	0.6	2.2
Community protection of food..	0	2	0	-	-	-

Two conclusions could be drawn from the above table. One, "Preservation of foods" shows sufficient strength in two cases to remove it from grade seven. There is not enough evidence to designate the exact grade. Two, the remainder of the items

should be placed in grade seven. Placement follows.

Grade 7	Grade 8 or 9
Types of food	Preservation of food
Sources of food	
Uses of food	
Food values	
Selection of foods	
Model meals	
Food advertising	

(18) Results in Clothing -- The results in this section are shown in Table XVII.

Table XVII

The Percentages of Response for the Several Items in Clothing Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Kinds of fabric.....	13	22	42	1.3	3.8	2.6
Making of Fabrics.....	7	18	33	1.9	3.9	2.1
Making of leather.....	2	17	27	3.1	4.5	1.4
Selection of clothing.....	7	22	31	2.5	3.6	1.2
Hygiene of clothing.....	14	25	35	1.6	2.8	1.3
Protection of clothing.....	5	1	33	1.3	4.3	5.5
Clothing advertisements.....	2	8	20	1.6	3.4	2.0
Cleansing of clothing.....	4	22	35	1.4	4.8	1.8
Fabric tests.....	0	0	2	-	-	-

As may be seen by the following grade placement, there is quite a bit of doubt as to where certain items should be taught. In several cases, although the ratio between grades seven and nine are important, the ratio of the same item between grades eight and nine are not significant, showing doubt about the placement of the item in grade nine. In some cases (as "Kinds of fabrics") the ratio in the last column is not three, but is large enough

to sway the item toward grade nine. The interesting grade list follows.

Grade 7	Grade 8 or 9
Hygiene of clothing	Making of fabrics
	Making of leather
Grade 9	Selection of clothing
	Clothing advertisements
Kinds of fabrics	Cleansing of clothing
Protection of clothing	

(19) Results in Chemistry -- Chemistry received the results as shown in Table XVIII.

Table XVIII

The Percentages of Response for the Several Items in Chemistry Together with the Critical Ratio of Difference.

Items	Percentage of Response			Critical Ratio		
	7	8	9	7 vs. 8	7 vs. 9	8 vs. 9
Chemistry in the home.....	2	6	18	1.2	3.0	2.1
Chemistry in the community....	2	3	15	0.3	2.9	2.5
Chemistry in industry.....	2	1	17	0.5	3.0	3.9
Chemistry on the farm.....	2	1	15	0.5	2.9	3.1
Chemistry in everyday life....	2	7	24	1.4	3.9	2.3
Simplified chemistry.....	2	2	0	-	-	-

"Chemistry in the community" is an item from this section which seems to be in doubt as to placement. However, with the low ratios in all columns it would be placed in grade seven. "Chemistry in the home" and "Chemistry in everyday life" are also in doubt in regards to their placement in either grade eight or nine. "Chemistry on the farm" and "Chemistry in industry" seem to be logical for grade nine. The set-up of this group is as follows:

Grade 7

Chemistry in the community

Grade 9

Chemistry in industry
Chemistry on the farm

Grade 8 or 9

Chemistry in the home
Chemistry in everyday life

(20) Results in Guidance -- Because no returns were made for grade seven, the tabulation which follows is only for grades eight and nine.

Table XIX

The Percentages of Response for the Several Items in Guidance Together with the Critical Ratio of Difference.

Items	Percentage of Response 8	9	Critical Ratio 8 vs. 9
Preview of high school chemistry	6	26	3.3
Preview of high school physics	6	26	3.3
Preview of high school biology	3	30	4.8

Here, it is easily seen that units of this type are most pupular in grade nine, particularly biology. Placement follows.

Grade 9

Preview of high school chemistry
Preview of high school physics
preview of high school biology

A summary list of the grade placement indicated in this chapter is shown in Chapter V.

CONCLUSIONS AND LIMITATIONS

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Chapter V

Conclusions and Limitations

This study was undertaken in the hope that at least two values might accrue--first, that it would reveal information as to what units in science were being taught in the Junior High Schools of Massachusetts; second, that it would show in what grades these units were being offered. The extent to which these hopes were realized is shown in the following lists which summarize the findings in Chapter IV.

(1) Items not being taught -- The percentage of response was so small in the case of the following items that it can be said that they are not being offered:

Telling time by the heavenly bodies
Comets and meteors
Diesel engines
Garbage disposal
Pictorial art
Modern architecture
Work of green plants
Photosynthesis
Living things in their environment
Phyla
Shellfish protection
Human sex education
Nervous system
Circulatory system
Planning a vacation
Bacteria harmful to man
Community protection of food
Fabric tests
Simplified chemistry

(2) Items taught in Grade VII -- In this list were placed those items with no critical ratios, as between grades, as great as 3.0. It would appear that teachers see no reason why these items should not be in grade seven.

(Grade 7)

The sun and its influence
Ancient beliefs about earth and stars
Recognition of common rocks and minerals
Earth formations
Changes in the earth's surface
Earth materials and their uses
Geology of the region
Temperature
Air pressure
Windmill
Types of industry
Study of local industry
Factors determining location of industries
Industrial diseases and their control
Safety in industry
Parks and their use
Modern explorations
Recognition of common trees
Recognition of common shrubs
Recognition of common flowers
Colorless plants and their recognition
Lower green plants and their recognition
Uses of trees and shrubs
Tree and shrub physiology
Garden preparation
Forests and their conservation
Preparation of plants for the seasons
Importance of plants to man
Bird recognition
Bird life and migration
Insect life histories
Response of animals to seasons
Animals useful to man
Conservation of wild life
Taste
Nutritional processes
Respiration
Waste disposal
Muscular system
Bone structure
Teeth
Reproductive processes
Cleanliness habits
Care of the body and its parts
Effect of exercise
Effect of alcohol and tobacco
The air we breathe
Common diseases
Prevention of disease
Bacteria helpful to man
First aid
Types of food

(Grade 7, continued)

Sources of food
Uses of food
Food values
Selection of foods
Model meals
Food advertising
Hygiene of clothing
Chemistry in the community

(3) Items taught in Grade VIII -- In this list would appear those items which are taught in grade 8 only. There is, according to the method used in this study, only one:

Storms.

(4) Items taught in Grade IX -- In this list are shown the items the critical ratios of which indicated their placement in grade 9.

Fire
Heat
Sound
Light
Primary machines
Steam engine
Water power
Gas engine
Electricity
Transmission of power
Magnetism
Science in industry
Early forms of transportation
Railroad
Transportation by water
Automobile
Airplane
Safe driving
Early forms of communication
Telegraph
Telephone
Wireless
Radio
Television
Building of streets and roads
Protection from fire
Protection from disease
Public service departments
Community planning and zoning
Building materials

(Grade 9, continued)

Types of buildings
Lighting in the home
Heating and ventilation
Modern conveniences
Musical instruments
Moving and talking photography
Microscopic animals
Sight
Hearing
Kinds of fabric
Protection of clothing
Chemistry in industry
Chemistry on the farm
Guidance for future courses in science

(5) Items in Grade VIII or IX -- Many items were listed in which the critical ratio of difference in response would indicate indecision as to whether the item should be in grade 8 or 9. These are:

Theories of earth's origin
The solar system
The sidereal or starry system
The constellations
The moon and its influence
Movements of the earth
Cloud formations
Winds and air currents
Weather corecasting
Sources of power
Water supply
Sewage disposal
Construction of buildings
Water supplies in the home
Great men of science
Uses of flowers
Flower parts
Animals without backbones
Animals with backbones
Preservation of foods
Making of fabrics
Making of leather
Selection of clothing
Clothing advertisements
Cleansing of clothing
Chemistry in the home
Chemistry in everyday life

(6) General conclusions -- From the above summary, several conclusions may be drawn:

(a) Nineteen items, or approximately twelve percent of the total check-list, are not being taught in the junior high schools of Massachusetts. Whether this is a defect in the check-list or indicates a lack in the science curriculum will be discussed in Chapter VI.

(b) Sixty or approximately thirty-nine percent of the check-list comprise a possible offering in grade seven.

(c) only one item is indicated as a possible offering only in grade eight.

(d) Forty-three or approximately twenty-seven percent of the check-list are preferably offered in grade nine.

(e) Thirty items or approximately nineteen percent of the check-list appear controversial. The critical ratios show indecision as between placement in grade eight or nine.

(f) It would appear that much more study must be made, as regards the items in (e) above, to discover their proper grade placement.

(g) The agreement as to placement in grade seven is much more pronounced than is the case in grades eight and nine.

(h) The findings of this study are not sufficiently clear-cut to serve as a sole basis for the development of a junior high school course of study in science.

A discussion of these conclusions in the light of their effect upon the major problem of course of study construction will be found in Chapter VI.

(7) Limitations -- If this study were to be repeated

or continued, the following changes would be made:

(a) The items on the list would be designated as topics rather than units. It is feared that teachers had the impression that each item was to be checked on the basis of whether or not they offered that item as a separate unit. It is thought possible that several items might very well be offered as part of another and larger unit.

(b) Only those schools which offered general science in the three grades would have been considered. This would prevent the overlapping evident in this study.

(c) The items showing indecision as between grades eight and nine should have been incorporated in a new check-list and returned to the teachers for a re-checking. Time did not permit.

IMPLICATIONS OF CONCLUSIONS

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Chapter VI

Implications of Conclusions

In Chapter V appear the conclusions which resulted from the check-list study. It remains to discuss and evaluate these conclusions in the light of utilizing them in the larger problem facing the writer. This discussion follows under appropriate headings.

(1) Items not being taught -- These items would be better discussed under three headings.

(a) Items too difficult for junior high school might be the first method of evaluation. Several of the items listed as not being taught are of a difficult nature and too mature for junior high school students. They would perhaps be better taught in the specialized science of the high school. These listed are as follows:

Telling time by the heavenly bodies
Photosynthesis
Phyla
Simplified chemistry
Human sex education

The last item is of controversial nature, and if it is taught at all, the high school seems the most logical place for its offering.

(b) Items which should be included in the curriculum is the second evaluation. To make out a well-rounded series of items in a particular field of science study, there are several of those listed as not being taught which should be included for the sake of sequence and coherence. Why they did not receive the expected response is a mystery to the writer. "Comets and meteors" should

receive some consideration when a class is dealing with planets and stars in order to make the picture of the heavens complete. Although they are not quite as common as other methods of transportation and power, "Diesel engines" should take its place in the syllabus because of its rapid development, and "Garbage disposal" is another topic which is needed to make the sequence of community study complete. "Living things in their environment" is an item exceedingly wide in scope; its use in the curriculum would encompass many of the items listed in the check-list. Two items closely allied to the rest of the work on physiology should be included with it; the "Nervous system" and the "Circulatory system" are as worthy of consideration as "Bone structure" and "Sight" which received noteworthy response in the check-list. "Shellfish protection" is an item which would be of local interest to several communities; while of little value in the inland towns it is of special interest to the municipalities along the shore.

(c) Several of the items could be offered in different courses. "Pictorial art" and "Modern architecture" are closely allied with art; they possibly would receive better emphasis in this field. "Planning a vacation" is a topic which would prove interesting in many different courses. It is a type of work calculated to touch upon or be related to either history, geography, English, and several other subjects. "Community protection of food" is an item which would be well placed in social studies. The study of the other items under community would augment and correlate with this work. "Fabric tests", an item which requires scientific approach, is an item seemingly more applicable in home economics than general science.

(2) Items being taught in grade seven -- On the whole the list of items signified as best taught in grade seven measures fairly well to requirements mentioned in chapters one and two. For the most part the list does outline a course which would interpret the child's own environment. The list might be criticized as being overly long. That is perhaps true. Several of the items might be taught elsewhere and the list made briefer. "Temperature" and "Air pressure" might well be taught in the grade where weather and its associated items were being offered. Those which refer to industry are of a type warranting consideration in social studies. The last eight or nine units mentioned under grade seven in the previous chapter, in relation to food, would fit very well into the home economics department of the junior high school. The rest would provide a fairly good basis for a curriculum in seventh grade science.

(3) Items being taught in grade nine -- The writer is quite satisfied with the list of the items for grade nine. From his readings the impressions received were that physical and dynamic science is the type of work offered in most ninth grade science courses, while nature study, hygiene, health and other items relating to the environment are taught in the lower grades. Several items in the list could be placed in other grades or subjects in order to produce a better sequence. "Sight" and "Hearing", in the opinion of the writer, should be included in the work relating to physiology. "Kinds of fabric" and "Protection of clothing" seem better placed in the sewing or home economics instruction.

(4) Items taught in either grade eight or grade nine -- If the writer were called upon to make a grade selection of the items classified as in doubt, he would follow the procedure of picking those items relating to the immediate environment for grade eight and those relating to the application of science to the environment for grade nine. The selection by grades follows:

Grade 8

Theories of the earth's origin
The solar system
The sidereal system
The constellations
The moon and its influence
Movements of the earth
Cloud formations
Winds and air currents
Weather forecasting
Great men of science
Uses of flowers
Flower parts
Animals with backbones
Animals without backbones

Grade 9

Sources of power
Water supply
Sewage disposal
Construction of buildings
Water supply for the home
Chemistry in the home
Chemistry in everyday life

Among those considered as being doubtful are those dealing with foods, leather, and clothing. These could be taught in the home economics department or be placed in grade eight. If the latter were done, the list would be as follows:

Grade 8

Preservation of foods
Making of fabrics
Making of leather
Selection of clothing
Clothing advertisements
Cleansing of clothing

While this method of choosing subjects may seem unscientific, it may be seen that if the procedure were followed, the continuity and sequence of the suggested list for grade nine would not be disrupted. It would also provide a list of items as a basis for eighth grade science.

APPENDICES

(1) Sample check-list questionnaire.

(2) Sample computation of critical ratio.

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Appendix I

Presented below is a copy of the check-list questionnaire used in this study.

George E. Higgins
Burlington, Mass.

AN ANALYSIS OF SCIENCE UNITS TAUGHT IN JUNIOR HIGH SCHOOLS AND THEIR GRADE PLACEMENT

The following units are arranged under the main subject fields taught in junior high schools. Since these are in this order for my convenience, they may be organized differently from your own curriculum. However, you will find that you can follow the sequence by checking down through the list. Should a unit, mentioned below, be taught in your school or course, place a check ( ) in the column marked "Taught"; in the column entitled "Grade", place the number of the grade in which the mentioned subject is taught--i.e., 7, 8, or 9.

EXAMPLE

TAUGHT	GRADE	
	8	Early forms of transportation
	7	Community water supply
	9	Geology of the region
		Cloud formations

Under each group of units are several lines where units which are taught in your school and which I have not included may be filled in.

CHECK LIST

TAUGHT	GRADE	
		ASTRONOMY
		The solar system
		The sun and its influence
		The sidereal or starry system
		The constellations
		The moon and its influence
		Movements of the earth and their results
		Theories of the earth's origin
		Ancient beliefs about the stars and the earth
		_____
		_____

TAUGHT GRADE

PHYSIOGRAPHY

Recognition of common rocks and minerals
Earth formations
Changes in the earth's surface
Earth materials and their uses to man
Soils and their uses
Geology of the region

WEATHER

Temperature
Air pressure
Winds and air currents
Storms
Cloud formations
Weather forecasting

ENERGY AND MACHINES

Fire
Heat
Sound
Light
Primary machines
Steam engine
Water power
Windmill
Gas engine
Electricity
Transmission of power
Magnetism

INDUSTRY

Types of industry
Study of local industries
Factors determining location
Sources of power
Science in industry
Industrial diseases and control
Safety in industry

TRANSPORTATION

Early forms

TAUGHT GRADE

TRANSPORTATION (Continued)

Railroad
Transportation by water
Automobile
Airplane
Safe driving

COMMUNICATION

Early forms
Telegraph
Telephone
Wireless
Radio
Television

COMMUNITY

Water supply
Sewage disposal
Building of streets and roads
Protection from fire
Protection from disease
Parks and their use
Public service departments
Community planning and zoning

HOMES AND BUILDINGS

Building materials
Types of buildings
Construction
Water supplies
Lighting in the home
Heating and ventilation
Modern conveniences

SCIENCE IN SOCIETY

Modern explorations
Great men of science
Musical instruments
Pictorial art

TAUGHT GRADE

SCIENCE IN SOCIETY (Continued)

Moving and talking photography
Modern architecture

PLANT LIFE

Recognition of common trees
Recognition of common shrubs
Recognition of common flowers
Colorless plants and their recognition
Lower green plants and their recognition
Uses of trees and shrubs
Uses of flowers
Flower parts
Tree and shrub physiology
Garden preparation
Forests and their conservation
Preparation of plants for the seasons
Importance of plants to man

PHYSIOLOGY

Sight
Hearing
Taste
Nutritional processes
Respiration
Waste disposal
Muscular system
Bone structure
Teeth
Reproductive processes
Human sex education

HYGIENE AND HEALTH

Cleanliness habits
Care of the body and its parts
Effect of exercise
Effects of tobacco and alcohol
The air we breathe
Common diseases
Prevention of disease
Bacteria harmful to man
First aid

TAUGHT GRADE

ANIMAL LIFE

Animals without backbones
Microscopic animals
Animals with backbones
Bird recognition
Bird life and migration
Insect life histories
Response of animals for the seasons
Animals useful to man
Conservation of wild life

FOOD AND NUTRITION

Types of food
Sources of food
Uses of food
Food values
Selection of foods
Model meals
Preservation of foods
Food advertising

CLOTHING

Kinds of fabric
Making of fabrics
Making of leather
Selection of clothing
Cleansing of clothing
Hygiene of clothing
Dyeing of clothing
Protection of clothing
Clothing advertisements

CHEMISTRY

Chemistry in the home
Chemistry in the community
Chemistry in industry
Chemistry on the farm
Chemistry in everyday life

TAUGHT GRADE

DO YOU GIVE GUIDANCE FOR FUTURE COURSES?

Preview of high school chemistry
Preview of high school physics
preview of high school biology

ADDITIONAL UNITS

DO YOU USE MARKS AS A BASIS FOR JUDGING WHETHER STUDENTS SHOULD TAKE FUTURE COURSES IN SCIENCE?

Appendix II

The critical ratio procedure of computing the reliability of percentage differences may not be familiar to some readers. Below is a sample of the computation involved, with the necessary description.

(1) Calculation of the Percentage of Response -- This was done by dividing the number of responses each item received by the number of schools which taught science in either grade seven, eight, or nine. 55 junior high schools taught science in grade seven, 72 in grade eight, and 66 in grade nine.

Number of Responses		Percentage of Responses
Grade 7	6	$55\overline{)6.000}$ .109 -- 11%
Grade 8	8	$72\overline{)8.00}$ .11 -- 11%
Grade 9	19	$66\overline{)19.000}$ .287 -- 29%

(2) Calculation of the Standard Error of Percentage -- By means of the formula $\sigma_P = \sqrt{\frac{Pq}{N}}$ the standard error of the percentage was found for each item. P is the percentage, q its complement, and N the number of schools.

Grade 7. $\sqrt{\frac{11 \times 89}{55}} = 4.2$

Grade 8. $\sqrt{\frac{11 \times 89}{72}} = 3.6$

Grade 9. $\sqrt{\frac{29 \times 71}{66}} = 5.5$

(3) Computation of the Standard Error of Difference Between Combinations of Grades -- The formula $\sigma_{dP} = \sqrt{\sigma_{P_7}^2 + \sigma_{P_8}^2}$ In this procedure, $\sigma_{P_7}^2$ is the standard error of grade seven percentage squared, $\sigma_{P_8}^2$ is that of grade eight squared, and $\sigma_{P_9}^2$ that of grade nine squared.

Standard error of difference between grades 7 and 8:

$$\sqrt{17.8 + 13.6} = 5.9$$

Standard error of difference between grades 7 and 9:

$$\sqrt{17.8 + 31.2} = 7.0$$

Standard error of difference between grades 8 and 9:

$$\sqrt{13.6 + 31.2} = 6.7$$

(4) Computation of the Critical Ratio of Difference -- The formula $\frac{D}{\sigma_d}$ was used in this procedure. D is the difference between the two percentages and σ_d the standard error of that difference.

Critical Ratio between grades 7 and 8:

$$\begin{array}{r} 11 \\ -11 \\ \hline 0 \end{array} \qquad \frac{0}{5.9} = 0$$

Critical Ratio between grades 7 and 9:

$$\begin{array}{r} 29 \\ -11 \\ \hline 18 \end{array} \qquad \frac{18}{7.0} = 2.5$$

Critical Ratio between grades 8 and 9:

$$\begin{array}{r} 29 \\ -11 \\ \hline 18 \end{array} \qquad \frac{18}{6.7} = 2.6$$

In this case of the critical ratio, none of the combinations showed a ratio as large as 3.0. Therefore, there was no significant difference in response.

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