PEDAGOGICAL RESEARCH IN CHEMISTRY
1925-1935

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CONTRIBUTIONS OF THE GRADUATE SCHOOL
INDIANA STATE TEACHERS COLLEGE
No. 222

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE MASTER OF SCIENCE DEGREE
IN EDUCATION
1935

ACKNOWLEDGMENTS

The writer wishes to acknowledge his indebtedness to the members of his thesis committee, Professor E. L. Abell, Dr. P. D. Wilkinson, and Dr. J. F. Mackell for the encouragement and assistance which they gave in the course of this study.

To Miss Laura Bingham and Mr. Morton Offit, the writer wishes to extend his thanks for the aid which they gave in tabulating data contained in this study.

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I. INTRODUCTION

A. The Need for Research in the Teaching of High School Science

Secondary education is in a process of transition. The first quarter of the twentieth century saw more changes in secondary education than any other equal period in American history.[1]

The changes in secondary education are probably the product of social evolution. As society evolves, so must our conceptions of secondary education change. Within recent years, we have witnessed many social changes. How these changes will effect secondary education in the future, we can not say with certainty.

The report of the Commission on the reorganization of secondary education on "Cardinal Principles of Secondary Education" recognizes that changes have taken place and that changes were in process, and it called attention to fundamental considerations which showed the manner in which the needs of society and the plan of the schools that were purporting to meet these needs were out of harmony.[2]

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[1]Cox and Long, Principles of Secondary Education, D. C. Heath Co., 192- p. 40.

[2]"Cardinal Principles of Secondary Education". United States Bureau of Education, Buletin No. 35, 1918. pp. 1-34.

Relative to the need for research in the field of secondary education, the Commission states:

> "It is becoming increasingly evident that the problems of secondary education merit much more serious attention than they have received heretofore. The study of the best methods for adapting secondary education to the needs of modern democratic life is just begun. Such knowledge of social needs and educational theory and practice as is already available has been seriously studied by comparatively few administrators and teachers. Plans must be adopted for pooling the results of successful experimentation of individual teachers."[3]

The need for reorganization in science was soon recognized after the Commission on the Reorganization of Secondary Education had made its report. Consequently, the Commission issued a series of reports on the reorganization of the various high-school subjects. The committee dealing with science teaching in the report, "The Reorganization of Science in the Secondary Schools",[4] considered the aims and objectives of science teaching. Relative to further need for research and reorganization in science teaching the committee states:

> "There is widespread recognition of the need of reorganizing science courses in secondary schools. Numerous encouraging efforts already have been made to redirect, enrich, and otherwise improve these courses. The variation of purposes for which sciences are taught, the increasing number of sciences offered, the development of intensive specialization within the science, the lack of sequence in the order in which they are usually given, the wide variation of content and method are striking evidences of the need for an approach to an agreement. Only by the comparison of the courses in

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[3] Ibid., p. 32.

[4] "Reorganization of Science in Secondary Schools". United States Bureau of Education, Bulletin No. 36, 1920.

> many progressive schools can any tendency towards such uniformity be perceived. Steps should be taken also to prevent this increase in number and specialization from diminishing the value of the instruction from the standpoint of the general needs of the pupils and the need of society."[5]

The report of the committee probably focused attention on the need for reorganization and research in science teaching. Before the report of the Committee on the Reorganization of Science in Secondary Schools very little research had been made in the teaching of science. Practically all the research that has been made in the teaching of science has been made within the last twenty-five years.[6]

In a subsequent part of this study it is shown that the number of researches in science at present exceed those made in any other field of secondary education.[7]

Curtis, in the preface of his first book, speaks of the large number of pedagogical research studies that had been made in secondary science at the time of the publishing of the book.[8]

The Committee on Science Teaching of the National Society for the Study of Education, in the Thirty-first Yearbook, A Program For Teaching Science states:[9]

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[5] Ibid., p. 11.

[6] F. D. Curtis, Investigations in the Teaching of Science, Blakiston's Son & Co., 1926. p. 27.

[7] See p. 11.

[8] Curtis, op. cit., p. 7.

[9] "A Program for Teaching Science", Thirty-first Yearbook Part I, National Society for the Study of Education, Public School Publishing Company, Bloomington, Illinois. 1932.

> "Excepting the fundamental subjects taught in the elementary schools, and the fields of the social sciences on secondary level, probably no part of the school curriculum has in recent years been so often and so critically subjected to the scientific study of education as the aims, methods, and curricula in science instruction. Some twenty experimental studies of the relative value of lecture demonstration and individual laboratory experimentation alone have been published in the last twenty-five years. These are, it is true, practically all on the elementary school and secondary school levels, but the tendency is general.
>
> Some of the reasons for this questioning attitude have already been mentioned. Science instructors are asking themselves what is wrong. Also, the natural sciences lend themselves, perhaps, more readily to scientific study of their methods and subject matter than other subjects. In addition there are undoubtedly social and economic factors underlying this decline in popularity and consequent inquiry into procedures. Whatever the causes, the fact is evident. We are directing science against science; we are subjecting science instruction to scientific study."[10]

The twentieth century has rightly been called the age of science. In no other period of the history of man has there been such a rapid increase in scientific knowledge. If our social order has changed within recent years, science, no doubt, has played an important part in this change.

Has secondary science evolved in accord with our changing social order, with our changing conceptions of secondary education? Has our method of presenting this wonderfully entrancing subject kept pace with its growth? There are vital questions, which research workers have attempted and are attempting to answer.

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[10] Ibid., p. 309.

B. The Purpose and The Plan of the Study

What is the nature of the pedogogical research in chemistry, and how much pedogogical research has been done in chemistry for a ten-year period, 1925-1935? What are, the trends revealed by these research studies? These are the questions which this study has attempted to answer.

The investigator first attempted to find all the theses and unpublished investigations in the teaching of science for a five-year period, 1928-1933. One-hundred and twenty studies were found.[11] Secondly, the extent to which these studies were made available to science teachers and other interested individuals in periodical literature was determined. These studies were obtained from the United States Office of Education, Bulletins, Bibliographies of Research Studies in Education from 1928-1933.[12]

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[11] See p. 15

[12] "Bibliographies of Research Studies in Education", United States Department of Interior, Education Bulletin No. 36. 1927-1928. Published, 1929.

"Bibliographies of Research Studies in Education", United States Department of Interior, Education Bulletin No. 37. 1929-1930. Published, 1931.

"Bibliographies of Research Studies in Education", United States Department of Interior, Education Bulletin No. 13. 1928-1929. Published, 1930.

"Bibliographies of Research Studies in Education", United States Department of Interior, Education Bulletin No. 16, 1930-1931. Published, 1932.

"Bibliographies of Research Studies in Education", United States Department of Interior, Education Bulletin No. 6, 1931-1932. Published, 1933.

It was ascertained whether each of the 120 studies had been published in magazine literature the year of its completion or for a two-year period following its completion. The Education Index, The Readers' Guide to Periodical Literature, The Loyola Index, and The Chemical Abstracts of the American Chemical Society were used in order to determine whether the study had been published in periodicals.

The number and the type of pedagogical research article found in magazines were next determined. An examination was made of all the issues of the Journal of Chemical Education and the School Science and Mathematics from 1925-1935, in order to find all published pedagogical research studies in chemistry.

Only by doing this was the writer certain that he had included in his study all pedagogical research studies found in, at least, two widely read periodicals, treating with science teaching. All other research studies that could be found by consulting bibliographies of textbooks, treating with the teaching of science, and the bibliographies of the articles found in the Journal of Chemical Education and School Science and Mathematics and the various indexes were used in this study. The number of articles used in this study was ninety-three. The writer believes that this represents the vast majority of pedagogical research studies in chemistry published from 1925-1935 in magazine literature.

Articles to receive consideration in this investigation had to conform to the following criteria: (1) approached from an

inductive standpoint, (2) definite objective, (3) clearly defined technique, (4) material organized in systematic order, (5) definite conclusions warranted by assembled data.[13]

The articles were next classified. Various texts treating with the teaching of chemistry were used as an aid in this classification. The amount of research devoted to the various problems of chemistry instruction was next determined. By means of this classification it was seen clearly what problems in secondary chemistry received the major attention by the researchers. A comparison was made of the findings of the major researches. By doing this, trends in chemistry from 1925-1935 were revealed.

C. Value of Study

This study is of value in that it may be used:

1. As a basis for comparison.
2. As a comprehensive reference source of pedagogical researches in chemistry from 1925-1935.
3. As a reference source relative to the type and amount of research devoted to the various types of pedagogical researches in chemistry from 1925-1935.
4. As a basis for determining where further pedagogical research is needed in chemistry.

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[13] E. M. Freeman, "Criteria for Judging a Science of Education". School and Society, Vol. XXX, 1929, pp. 45-52.

D. Similar Studies

There is no study that has been made, to the writer's knowledge, which is a comprehensive survey of pedagogical researches in chemistry over a period of years. However, several studies have been made which reviewed the literature in the field of science and attempted to show trends. These studies included many references to pedagogical research studies that had been made in chemistry.

Probably the most outstanding work in this field is: The Thirty-first Yearbook of the National Society for the Study of Education, a program for teaching science.

The general features of this yearbook are set forth in the first ten chapters. Chapters I to V give in order: (1) the Committee's interpretation of what seem to be best practices in planning the work of elementary and secondary schools, together with the more general features of its own recommendations for science teaching; (2) criticisms of some current practices that must be modified in order to accomplish the program outline; (3) an analysis, with illustrations, that shows some of the contributions to life enrichment that may be expected from the field of science; (4) a definition of the field of science that is at least fairly comprehensive, given in terms of major principles and generalizations that may be used for guidance in selecting the specific objectives of science teaching; and (5) a brief interpretation of the principles of psychology that have guided the Committee in constructing its program.

In Chapters VI to IX, inclusive, there is an analysis of the contributions from educational research that relate to the field of science teaching. In these chapters are presented, in order, interpretations of research relating: (1) to problems of classroom teaching; (2) to problems of laboratory teaching; (3) to the content of science courses; and (4) to curricular developments in school centers.

Chapters X to XV, inclusive, carry recommendations for each of the administrative units of the public school. These are followed by a chapter (XVI) on rooms and equipment for science teaching, with recommendations for each of the administrative units.

In Chapter XVII, on science teaching on the college level, attention is given to problems associated with the integration of high-school and college courses.

In Chapter XVIII, on the education of teachers of science, it is assumed that the requisites for success in such teaching are: first, that the teacher shall be a liberally educated person; second, that he shall be a specialist in science; and third, that he shall be professionally educated, in the sense that he will be familiar with the problems associated with teaching and in command of the techniques that are necessary for successful work in the classroom. The program for the education of teachers is, therefore, a program of liberal education including a good measure of specialization and, at the same time, a program of professional education.

Curtis has written two books which are composed of digests of investigations in the teaching of science. They are "Investigations in Teaching of Science"[15] and "A Second Digest of Investigations in the Teaching of Science".[16] The first book represents an endeavor to include the learning studies in elementary and secondary school science published before 1925; but no attempt has been made to include all of the curricular studies. Because of the great number of these studies, this report places its stress mainly upon the investigations published during the period from 1920 to 1925, and presents only such researches published before 1920 as seem in the author's judgment to give data of more or less permanent value.

Digests of seventy different learning and curricular studies compose the body of the book. The form of the digest of each article is that adopted by the Department of Superintendence, N. E. A., in its Third Yearbook. A brief statement of the Problem; a description of the method or technique used in obtaining the data; and a detailed list of the Findings, including, usually, conclusions and, occasionally, recommendations.

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[15] F. D. Curtis, op. cit.

[16] Francis D. Curtis, A Second Digest of Investigations in the Teaching of Science. Blakiston's Son & Co., 1930

Separate lists of Conclusions and Recommendations are given only when the investigator has summarized the results of the investigation, or of several separate investigations or units of an investigation.

In his first book Curtis, as has already been stated, considered only pedagogical researches in the elementary and secondary field. In his second book, he included pedagogical researches in both college and secondary science. Curtis[17] stated that the pedagogical researches in science were so voluminous that it was impossible to include all of them or even a majority of them in one book. Consequently, the members of the National Association for Research in Science Teaching were asked to submit researches in the science field that they considered important. From this list Curtis selected the studies which he included in his second book.

Good[18] made a study of researches in the secondary school subjects, grades 7-12 inclusive from 1918-1927. He made a study to discover significant contributions to sceondary methods published in non-periodical form. He also made a survey of the research in secondary methods which has appeared in periodical literature 1926-1929. Of the 552 studies found in periodical literature, seventy-two were in science which ranked

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[17] Curtis, op. cit., Vol. II.

[18] Carter V. Good, "Research in Secondary School Methods", Journal of Educational Research, Vol. 22, June 1930. pp. 9-30.

first. The social studies ranked second with sixty-eight studies in this field.

Good[19] found that in science methods that the most numerous and intensive researches have dealt with laboratory versus the demonstration method.

Glenn[20] made an analysis of 455 articles compiled from the work of 282 authors for the years covering the period 1890 to 1925. He found that seventy-three per cent of the authors contributed only one article from 1890-1925, fourteen and one half per cent wrote two articles and four per cent wrote three articles. Over ninety per cent of these authors wrote less than four articles in their chosen field of work.

Concerning the value of these articles Glenn stated:

> "A survey of the articles that have been written on the teaching of chemistry during the past twenty-five years, reveals the fact that most of these papers are of no importance now, and were never of much importance. Most of the papers are short, poorly organized, and show no careful study of the scientific or educational literature bearing on the subject."[21]

A Committee on Research Problems of High-school Chemistry Instruction of the Division of Chemical Education of the American Chemical Society compiled a bibliography on high school chemistry instruction.[22]

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[19] Ibid., p. 11.

[20] Earl R. Glenn, "The Need for Research on Problems of High-school Chemistry Instruction". Journal of Chemical Education Vol. II. 1930. pp. 670-73.

[21] Ibid., p. 671.

[22] "Research Problems of High-school Chemistry Instruction." Journal of Chemical Education, Vol. 7. Sept. 1930, pp. 2158-2159.

This represented a survey of articles published in the Journal of Chemical Education from 1924 to 1930. It was explained that the list of articles represented by no means a comprehensive survey of all the articles published in this interval in the Journal of Chemical Education.

II. PEDAGOGICAL RESEARCH STUDIES IN CHEMISTRY 1928-1933

A. The Specific and General Research Studies in Chemistry

The most inclusive compilations, to the writer's knowledge, of research studies that have been made in colleges and universities, and by Research Divisions of city school systems are found in the bulletins of United States Office of Education, Bibliographies of Research Studies.[1] These bulletins also contain some published researches and some researches that were published in magazines. The writer, though, was interested in studies made for a higher degree, published or unpublished, and those made by Research Divisions of city school systems and colleges and universities from 1928-1933. Studies were found devoted specifically to some phase of chemistry, and studies that did not treat with any one of the special sciences but were applicable to some of the special sciences and particularly to chemistry. These two groups have been designated respectively as the specific studies and the general studies. Table I shows the distribution of the amount of specific and general pedagogical research in chemistry from 1928-1933. The total number of studies found was 120. Eighty-eight of these studies were specific studies which represent 73.2 per cent of the total. Thirty-two of these studies were general studies, which represent 26.7 per cent of the total.

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[1] United States Office of Education Bulletins, op., cit. p.5.

TABLE I.

DISTRIBUTION OF THE AMOUNT OF SPECIFIC AND GENERAL, PEDAGOGICAL STUDIES IN CHEMISTRY FROM 1928-1933

Year	Number Specific Studies	Per Cent	Number General Studies	Per Cent	Total Studies	Total Per cent
1928	15	17.1	4	12.5	19	15.8
1929	18	20.04	2	6.2	20	16.6
1930	23	26.1	12	38.5	35	29.1
1931	24	27.2	9	28.1	33	27.5
1932	8	9.9	5	15.6	13	10.8
TOTAL	88	73.3	32	26.7	120	100.

B. By Whom the Studies were Sponsored.

Table II shows the distribution and percentage of studies according to the institution or researh division that sponsored the studies. Of the one hundred and twenty studies, twenty-two of 18.33 per cent were sponsored by universities, six or five per cent by liberal arts colleges, and three or 2.5 per cent by Research Divisions of city shool systems.

TABLE II

DISTRIBUTION AND PERCENTAGE OF STUDIES ACCORDING TO INSTITUTIONS AND RESEARCH DIVISIONS THAT SPONSORED THE STUDIES

Institutions	Number of Studies	Per cent
Teachers' College	22	18.33
University	89	74.17
Liberal Arts College	6	5
Research Divisions of City School Systems	3	2.5
TOTAL	120	100

C. The Studies Made for Higher Degrees.

Table III shows the number and percentages of pedagogical studies in chemistry made for the masters' and doctors' degrees and those not made for any degree. It is seen that 74.2 per cent of the studies were masters' studies, that 10.8 per cent were doctors' studies, and that 15 per cent were not made for a degree.

TABLE III

THE NUMBER AND PERCENTAGE OF PEDAGOGICAL STUDIES MADE FOR THE MASTERS' AND DOCTORS' DEGREES AND THOSE NOT MADE FOR ANY DEGREE FROM 1928-1933

The Number Masters' Studies	Per Cent	The Number Doctors' Studies	Per Cent	Not Made For A Degree	Per Cent	Total Studies	Per Cent
89	74.2	13	10.8	18	15	120	100

D. The Types of Pedagogical Studies in Chemistry

Table IV is a classification of the pedagogical studies according to type. They are given in the order of the number of studies devoted to each type. The classification is to a large extent, that used by Frank[2] in his book treating with the teaching of high-school chemistry. The writer also found the classification of science articles used by the Education Index helpful. In view of the limited information concerning some of these studies, no attempt was made to make an extensive classification. The classification is, as apparent, very general. In the majority of the studies, there was no question as to the type it represented as found in Table IV. It was true, in a few cases, that a study could represent one or more types. In these cases, the major emphasis of the studies was considered in their classification.

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[2] J. O. Frank, The Teaching of High School Chemistry. (Oskosh, Wis.: J. O. Frank & Sons), 1932. pp. 1-281.

Table IV shows that the studies that treat with tests and measurements in chemistry ranked first, with seventeen studies or 14.16 per cent of all of the studies of this type. Analysis of chemistry laboratory manuals or chemistry text-, books ranked second with 16 studies or 13 per cent devoted to this type. The next type of study, classroom methods of teaching chemistry and science, ranked third with 15 studies or 12.5 per cent of all the studies falling under this class. It is true that lecture-demonstration method is considered as either a laboratory method or a classroom method. Consequently, it was classed under neither. Any study which attempted to ascertain any relationship of high-school and college chemistry was placed under number four in Table IV. There were 13 such studies or 10.8 per cent of all studies. There were ten studies that were state surveys or 8.33 per cent of all studies. There were six studies that were classed under enriched teaching. This is a rather general term, used by Frank,[3] that includes all methods, ways, devices, apparatus, and tools to enrich the course in the teaching of chemistry, such as, chemistry or science clubs, field trips, exhibits, pictures, bulletin board, scrap books, etc. Laboratory teaching included six studies or 5 per cent of all studies. There were six studies that were classified as miscellaneous. This represented 5 per cent of all studies. The nature of these studies was not sufficiently known to justify their classification.

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[3] Ibid., pp. 164-185

Any study that analyzed any type of literature, as a basis for the solution of problems relating to pedagogical chemistry, was placed under number nine in the outline. There were six such studies or 5 per cent of the total. Any study that determined the relationship of high-school chemistry with other subjects was classified under number ten in Table IV. Four studies each were devoted to analysis of students' interests, history of chemistry, and the lecture-demonstration method. Three studies each were devoted to aims of chemistry teaching and school surveys of chemistry teaching. One study was a national survey of chemistry teaching.

TABLE IV

THE TYPES OF PEDAGOGICAL STUDIES IN CHEMISTRY IN ORDER OF THE NUMBER OF STUDIES DEVOTED TO EACH

Types of Studies	Number of Studies	Per cent
Tests and Measurements	17	14.16
Analysis of Chemistry Laboratory Manuals and Textbooks	16	13.30
Classroom Methods of Teaching Chemistry and Science	15	12.5
Relationship of High-school and College Chemistry	13	10.8
State Surveys of Chemistry Teaching	10	8.33
Enriched Teaching	6	5
Laboratory Teaching	6	5
Miscellaneious Studies	6	5
Analysis of Literature as a Basis for the Solution of Problems Related to Pedagogical Chemistry	6	5
Correlation with Other Subjects	5	4.16
Analysis of Students' Interests	4	3.33
History of Chemistry Teaching	4	3.33

TABLE IV (Continued)

Lecture Demonstration Method	4	3.33
Aims of Chemistry	3	2.5
School Surveys of Chemistry Teaching	3	2.5
National Survey of Chemistry Teaching	1	8.83
TOTAL	120	100

E. The Reviews of Pedagogical Studies That Were Published in Magazines

To what extent are reviews of pedagogical research studies in chemistry found in magazines? After having determined the number of studies made each year from 1928-1933, a thorough search was made in order to ascertain whether each of the studies was published the year of its completion or for a two-year period following. The writer failed to find any study published for a period greater than two years after its completion.

Table VI shows the pedagogical studies made in chemistry in 1928, and the year in which these studies were published. Of the nineteen studies made in 1928, none was published in 1928. Four were published in 1929 and one in 1930, a total of five studies published or 26.3 per cent of all the studies made in 1928.

Table VII shows the studies made in 1929, abstracts of which were published in magazines in 1929, 1930, 1931. Of the twenty studies made in 1929, four were published or 20 per cent of all studies made.

Table VIII shows that of the 35 studies made in 1930, four or 11.4 per cent were published.

Table IX shows that of the 33 studies made in 1931, six or 18.1 per cent were published.

Table X shows that of the 13 studies made in 1932, the abstract of only one was published in any magazine.

Table XI is a summary of the number of studies published in magazines the year of their completion and for a two-year period afterwards. Four or 20 per cent of the studies were published the year of their completion; thirteen or 65 per cent of the studies were published the year after their completion; three or 15 per cent of the studies were published the second year after their completion.

Table XII is a summary showing the distribution of the number of pedagogical studies published in magazines from 1928 to 1933. A total of twenty studies was published in magazine literature from 1928 to 1933. Therefore, 17.4 per cent of the studies made form 1928-1933 were published in magazine literature.

Table XIII shows the number of articles that reviewed research studies found in various magazines from 1928-1933. It is shown that eleven magazines published abstracts of researches' studies in chemistry from 1928 to 1933. Eight of these magazines published only one article from 1928 to 1933. This represents 38 per cent of all articles published. One magazine published three articles which represent 14.2 per cent of all articles published. Two magazines each published five articles, which represent 47.6 per cent of all articles published. The writer found only one study, the abstract of which was found in more than one magazine.

TABLE V

THE PEDAGOGICAL STUDIES MADE IN CHEMISTRY IN 1928 THAT WERE PUBLISHED IN MAGAZINES IN 1928, 1929, 1930

Number of Studies Made in 1928	The Number and Year in which Abstracts of Studies were Published in Magazines				
	1928	1929	1930	Total	Per Cent
19	Number of Studies Published	Number of Studies Published	Number of Studies Published		
	0	4	1	5	26.3

TABLE VI

THE PEDAGOGICAL STUDIES MADE IN CHEMISTRY IN 1929 THAT WERE PUBLISHED IN MAGAZINES IN 1929, 1930, 1931

Number of Studies Made in 1929	The Number and Year in Which Abstracts of Studies were Published in Magazines				
	1929	1930	1931	Total	Per Cent
20	Number of Studies Published	Number of Studies Published	Number of Studies Published		
	1	2	1	4	20

TABLE VII

THE PEDAGOGICAL STUDIES MADE IN CHEMISTRY IN 1930 THAT WERE PUBLISHED IN MAGAZINES IN 1930, 1931, 1932

Number of Studies Made in 1930	The Number and Year in which Abstracts of Studies were Published in Magazines				
	1930	1931	1932	Total	Per Cent
35	Number of Studies Published	Number of Studies Published	Number of Studies Published		
	2	2	0	4	11.4

TABLE VIII

THE PEDAGOGICAL STUDIES MADE IN CHEMISTRY IN 1931 THAT WERE PUBLISHED IN MAGAZINES IN 1931, 1932, 1933

Number of Studies Made in 1931	The Number and Year in which Abstracts of Studies were Published in Magazines				
	1931	1932	1933	Total	Per Cent
33	Number of Studies Published	Number of Studies Published	Number of Studies Published		
	0	5	1	6	18.1

TABLE IX

THE PEDAGOGICAL STUDIES MADE IN CHEMISTRY IN 1932 THAT WERE PUBLISHED IN MAGAZINES IN 1932, 1933, 1934

Number of Studies Made in 1932	The Number and Year in which Abstracts of Studies were Published in Magazines				
	1932	1933	1934	Total	Per Cent
13	Number of Studies Published	Number of Studies Published	Number of Studies Published		
	1	0	0	1	.92

TABLE X

A SUMMARY SHOWING THE NUMBER OF REVIEWS OF STUDIES IN CHEMISTRY PUBLISHED IN MAGAZINES THE YEAR OF THEIR COMPLETION AND FOR A TWO-YEAR PERIOD AFTERWARDS

Studies	Number	Per Cent
Published in Magazines the Year of their Completion	4	20
Published in Magazines the following Year after Completion	13	65
Published in Magazines in the Second Year after Completion	3	15
Total	20	100

TABLE XI

A SUMMARY SHOWING THE DISTRIBUTION OF THE NUMBER OF PEDAGOGICAL STUDIES IN CHEMISTRY PUBLISHED IN MAGAZINES FROM 1928-1933

Year	Number of Studies Published In Magazines	Per Cent
1928	5	25
1929	4	20
1930	4	20
1931	6	30
1932	1	5
Total	20	100

TABLE XII

NUMBER OF ARTICLES, THAT REVIEWED PEDAGOGICAL RESEARCH STUDIES IN CHEMISTRY, FOUND IN VARIOUS MAGAZINES FROM 1928-1933

Number of Articles	Number of Magazines in which This number of Articles was Found	Per Cent of Articles Found in this Number of Magazines
1	8	38
2	0	0
3	1	14.2
4	0	0
5	2	47.6
Total[4] 21	11	100

[4]The total is twenty-one because there was one article that appeared in two periodicals.

F. Summary and Conclusions

From 1928 to 1933, one hundred twenty pedagogical research studies were found that were made in colleges and universities and by Research Divisions or Bureaus of city school systems. Seventy-three and three tenths per cent of the research studies treated specifically with some aspect of chemistry teaching. Twenty-six and seven tenths per cent of the studies were general research studies, applicable to some of the other sciences. Seventy-four and two tenths per cent of the studies were made for masters' degrees, which represent a great majority of all studies made. Ten and eight tenths per cent of the studies made were for doctors' degrees, while only fifteen per cent of the studies were not made for any degree.

Seventy-four and seventeen hundrenths per cent of the studies were sponsored by the universities and eighteen and thirty-three per cent of the studies by teachers colleges, five per cent by liberal arts colleges, and two per cent by Research Divisions of city school systems.

The types of research studies listed in order of the number of studies devoted to each are: (1) tests and measurements, 14.16 per cent, (2) analysis of chemistry laboratory manuals, 13.3 per cent, (3) classroom methods of teaching chemistry and science, 12.5 per cent, (4) relationship of high school and college chemistry, 10.8 per cent, (5) state surveys of chemistry teaching, 8.33 per cent,

(6) enriched teaching, 5 per cent, (7) laboratory teaching, 5 per cent, (8) miscellaneous studies, 5 per cent, (9) analysis of literature as a basis for the solution of problems related to secondary chemistry, 5 per cent, (10) correlation with other subjects, 4.16 per cent, (11) analysis of students' interests, 3.33 per cent, (12) history of chemistry teaching, 3.33 per cent, (13) lecture-demonstration method, 3.33 per cent, (14) aims of chemistry teaching, 2.5 per cent, (15) school surveys of chemistry teaching, 2.5 per cent, (16) national surveys of chemistry teaching, 1 per cent.

Of the one hundred twenty research studies, an abstract of only twenty were ever published in any magazine. Two magazines published 47.6 per cent of all research studies that were published in magazines. One magazine published 14.2 per cent of all studies published. Eight magazines published 38 per cent of all published reviews.

The reviews of the majority of the studies were published the year following their completion. Reviews of thirteen studies were published in magazines the year after their completion or 65 per cent of the total number of studies published. Four reviews of studies were published in magazines the year of their completion or 20 per cent of all studies published. Three studies were published in magazines the second year after their completion, constituting fifteen per cent of all studies published.

III. THE PEDAGOGICAL RESEARCH IN MAGAZINE LITERATURE 1925-1935

A. The Amount of Specific and General Pedagogical Research in Magazine Literature from 1925-1935

Table XIII shows the distribution of the number of specific and general research studies in magazine literature from 1925-1935.[1] A total of ninety-three studies was found. Seventy-two per cent of the studies were specific studies or 77.5 per cent of all studies found. Twenty-one studies were general studies or 22.5 per cent of all studies found in magazine literature. The largest number of studies was found in 1929 which was sixteen studies or 17.2 per cent of all the studies found in magazine literature. The smallest number of studies, which was four or 4.3 per cent of all studies found, was found in magazine literature in 1933. An average of nine and three tenths per cent of pedagogical research studies in chemistry were published each year from 1925 to 1935 in magazine literature.

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[1]See p. 14.

TABLE XIII

DISTRIBUTION OF THE NUMBER OF SPECIFIC AND GENERAL PEDAGOGICAL RESEARCH STUDIES IN MAGAZINE LITERATURE FROM 1925-1935

Year	Number of Specific Studies	Per Cent	Number of General Studies	Per Cent	Total Studies	Per Cent
1925	11	15.2	2	9.5	13	13.9
1926	7	9.7	2	9.5	9	9.6
1927	8	11.1	1	4.7	9	9.6
1928	6	8.3	3	14.2	9	9.6
1929	15	20.8	1	4.7	16	17.2
1930	7	9.7	0	0.0	7	7.5
1931	5	6.9	3	14.2	8	8.5
1932	7	9.7	4	19	11	11.8
1933	1	1.3	3	14.2	4	4.3
1934	5	6.9	2	9.5	7	7.5
Total	72	77.5	21	22.5	83	100

B. The Length of the Articles

Glenn[2] in an analysis of 455 articles in magazine literature in chemistry in 1930 found that most of the articles were very short. Articles were one page in length. Glenn considered both research and controversial articles.[3]

Table XIV shows the length of the pedagogical research articles in chemistry in magazine literature from 1925 to 1933. The length of the articles range from one page to forty-two pages. There was only one article one page in length. There was a total of five hundred seventy-two pages devoted to a review of the ninety-three research studies in chemistry. The average length of all the articles was six and two tenths pages. These data relative to length of the articles, do not conform to those of Glenn.

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[2] Glenn, op. cit., p. 572.

[3] A research article is considered one that discusses a research study.

TABLE XIV

THE LENGTH OF PEDAGOGICAL RESEARCH ARTICLES FOUND IN MAGAZINE LITERATURE 1925-1935

Number of Pages Devoted to Articles	Number of Articles This Length	Per cent of Articles This Length
1	1	1.1
2	8	8.6
3	5	5.3
4	7	7.5
5	10	10.5
6	7	7.5
7	11	12.2
8	12	12.9
9	7	7.5
10	6	7.5
11	7	6.4
12	1	7.5
13	2	1.1
14	2	2
16	1	2
21	1	1.1
24	1	1.1
25	1	1.1

TABLE XIV (Continued)

	30	1	1.1
	31	1	1.1
	42	1	1.1
Total	572	93	100

C. The Writers of the Pedagogical Research Articles in Chemistry in Magazine Literature from 1925-1935

1. The Number of Contributions Made by the Writers

Table XV shows the number of contributions made by the writers of the research articles. The table shows that sixty-seven different writers made only one contribution from 1925 to 1935. This represents seventy-two per cent of all research articles published in this interval. Five writers made two contributions each, representing 10.7 per cent of all research articles published. Three writers made three contributions each, which represents 8.7 per cent of all studies published. One writer made seven contributions which represents 7.5 per cent of all studies. The table shows that seventy-six writers made ninety-three contributions.

TABLE XV.

THE NUMBER OF CONTRIBUTIONS MADE BY THE WRITERS OF RESEARCH ARTICLES

Number of Contributions	Number of Writers Who made This Number of Contributions	Per cent of Writers who Made This Number of Contributions
1	67	72
2	5	10.7
3	3	8.7
7	1	7.5
Total 93	76	100.

2. The Institutions With Which the Writers Are Affiliated.

Table XVI shows the number of articles contributed by the writers affiliated with the various types of institutions. Thirty-two articles or 34.4 per cent of the articles were contributed by individuals affiliated with the universities. Twenty-nine articles or 31 per cent of the articles were contributed by individuals affiliated with the high-schools. Sixteen articles or 17.2 per cent of the articles were contributed by individuals affiliated with teachers colleges. Twelve articles or 12.9 per cent of all the articles were contributed by individuals affiliated with the liberal arts colleges. Four articles or 4.4 per cent of all the articles were contributed by individuals whose schools were not known.

TABLE XVI

THE NUMBER OF PEDAGOGICAL RESEARCH ARTICLES IN CHEMISTRY FROM 1925-1935 CONTRIBUTED BY THE WRITERS AFFILIATED WITH THE VARIOUS TYPES OF INSTITUTIONS

The Type of Institution	The Number of Articles Contributed by the Writers Affiliated with this Type of Institution	Per cent
University	32	34.4
High-school	29	31.0
Teachers College	16	16.2
Liberal Arts College	12	12.9
School not Given	4	4.4

D. Types of Pedagogical Research Studies in Chemistry in Magazine Literature 1925-1935

Table XVII is a classification of the pedagogical research studies in chemistry, according to types and subtypes and the number of researches devoted to each type and subtype. The same means and basis were used in classifying the research studies in magazine literature as was used in classifying the studies in Chapter II.[4] This is an extensive classification of all research studies in magazine literature of 1925-1935.

The survey studies rank first with eighteen or 19.3 per cent of the studies of this type. Tests and measurements rank second with sixteen or 17.1 per cent of this type. The relationship of high school and college chemistry ranks third with thirteen studies of this type or 13.9 per cent of all the studies. Classroom teaching of chemistry ranks fourth with nine studies of this type or 9.6 per cent of all the studies. Enriched teaching ranks fifth with seven studies of this type or 7.5 per cent of all the studies. Laboratory methods rank sixth with six studies or 6.4 per cent of all studies. All studies which attempted to determine what is being taught in chemistry and the organization of the subject matter of chemistry that is taught were classed as subject matter studies. There were five studies of this type or 5.3 per cent of the studies. Five or 5.37 per cent of the studies were analysis

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[4]See page 17.

of textbooks or laboratory manuals. Four studies or 4.3 per cent of all studies were studies that treated with the lecture demonstration versus individual laboratory method. There were four studies that were analyses of periodical literature. There were three studies devoted to the aims of chemistry teaching. There were two studies devoted to lecture versus laboratory work. There was one study which was a history of chemistry teaching.

No attempt has been made to analyze the subtypes of the general types. In the subsequent chapters of this study, extensive analyses are made of the major general types and their subtype studies.

TABLE XVII

A CLASSIFICATION OF THE TYPES OF PEDAGOGICAL RESEARCH STUDIES IN MAGAZINE LITERATURE 1925-1935, ARRANGED IN ACCORDANCE WITH THE NUMBER OF STUDIES DEVOTED TO EACH OF THE GENERAL TYPES

Types of Studies	Number	Per cent
I. SURVEY		
1. State Survey of Chemical Education	11	11.82
2. Survey of Chemical Education in several states	2	2.15
3. Survey of Science Teachers	4	4.30
4. Science Classrooms	1	1.07
Total	18	19.34
II. TESTS AND MEASUREMENTS		
1. Diagnostic Tests	6	6.45
2. Teaching Tests	2	2.15
3. Achievement Tests	2	2.15
4. Comparison Tests	5	5.37
5. Reliability of Examination Marks	1	1.07
Total	16	17.19

TABLE XVII (Continued)

III. RELATIONSHIP OF COLLEGE AND HIGH SCHOOL CHEMISTRY		
1. Influence of High School Chemistry on College Grades	8	8.6
2. General relationship of High School and College Chemistry	3	3.22
3. Whether students who study High School Chemistry elect Chemistry in College	2	2.15
Total	13	13.97
IV. CLASSROOM TEACHING		
1. Methods of Presenting subject matter	3	3.22
2. Study methods	1	1.07
3. Term paper Practices	1	1.07
4. Sectioning	3	3.22
5. Criticism of Teaching Methods	1	1.07
Total	9	9.67
V. ENRICHED TEACHING		
1. Visual Education	4	4.3
2. Science Clubs	2	2.15
3. Activities of Science Students	1	1.07
Total	7	7.52

TABLE VII (Continued)

VI. LABORATORY METHODS		
1. Laboratory Practices	4	4.3
2. Notebooks	2	2.15
Total	6	6.45
VII. SUBJECT MATTER OF CHEMISTRY		
1. Contents of Courses	2	2.15
2. Reorganization	3	3.22
Total	5	5.37
VIII. ANALYSIS OF LABORATORY TEXTBOOKS AND MANUALS		
1. Textbook Analysis	4	4.3
2. Laboratory Manual Analysis	1	1.07
Total	5	5.37
IX. LECTURE DEMONSTRATION VERSUS INDIVIDUAL LABORATORY METHOD	4	4.3
X. ANALYSIS OF PERIODICAL LITERATURE	4	4.3
XI. AIMS OF CHEMISTRY TEACHING	3	3.22
XII. LECTURE VERSUS LABORATORY WORK	2	2.15
XIII. HISTORY OF CHEMISTRY TEACHING	1	1.07
TOTAL	93	100.00

E. Summary and Conclusions

From 1925-1935 the writer found ninety-three studies that were published in various magazines that treated with pedagogical aspects of chemistry. Of these ninety-three studies seventy-two or 77.5 per cent were specific studies; twenty-one or 22.5 per cent were general studies. There were five hundred seventy-two pages devoted to reviews of these studies, with an average of 6.2 pages to each study. A majority of the writers of these articles made only one contribution in a ten-year period. One writer made seven contributions from 1925-1935.

Thirty-four and four tenths per cent of the articles were contributed by individuals affiliated with the universities, thirty-one per cent by those affiliated with high-schools, and 12.9 per cent by those affiliated with teachers colleges. The type of studies listed in the order of the number of studies devoted to each are: (1) surveys, (2) tests and measurements, (3) relationship of high school and college chemistry, (4) enriched teaching of chemistry, (5) laboratory teaching, (6) classroom teaching of chemistry, (7) subject matter of chemistry, (8) analysis of laboratory manuals and textbooks, (9) laboratory demonstration versus lecture demonstration, (10) analysis of periodical literature, (11) aims of chemistry teaching, and (12) history of chemistry.

IV. THE CONTRIBUTIONS OF RESEARCH, IN MAGAZINE LITERATURE 1925-1935, TO THE STATUS OF CHEMICAL EDUCATION

A. The Types of State Survey Studies in Magazine Literature

1. The Specific and General Survey Studies in Magazine Literature from 1925-1935

Table XVIII shows the specific and general survey studies, and the types of studies which they represent. There were eighteen studies that were found that were classified as survey studies. Of the eighteen survey studies, eleven studies or 51.1 per cent were state surveys of chemical education. Two surveys were surveys of chemical education in several states. This represents 11.1 per cent of the studies. Four studies were surveys of science teachers which represents 22.2 per cent of the studies. One study was a survey of science classrooms which represents 5.5 per cent of the survey studies.

TABLE XVIII

THE SPECIFIC AND GENERAL SURVEY STUDIES IN CHEMICAL EDUCATION IN MAGAZINE LITERATURE 1925-1935 AND THE TYPES OF STUDIES WHICH THEY REPRESENT

Type of Survey	The Specific Survey Studies[1]	The General Survey Studies	Number	Per Cent
State Surveys of Chemical Education	(52) (89) (86) (74) (60) (58) (34) (50)	(92) (23) (42)	11	61.1
Survey of Chemical Education in Several States		(20) (40)	2	11.1
Survey of Science Teachers	(31) (11)	(93) (2)	4	22.2
Science Classrooms		(30)	1	5.5
TOTAL			18	100

[1] The numbers in brackets are the numbers of the studies found in the appendix.

2. Some Facts Relative to the State Survey Studies

Table XIX shows some facts relative to the state survey studies of chemical education in eleven states. Four of the survey studies were published in magazine literature before 1929. Four studies were published in 1929. Two were published in 1931 and one in 1933. All but one used the questionnaire method of collecting the data. The smallest number of schools surveyed was seventy-two (Study number 89). The largest number of schools surveyed was three hundred and two (Study number 92). Four of the states surveyed were Southern States, namely; South Caroline, two surveys, Texas, two surveys. Five states surveyed were Mid-Western States, namely; Iowa, Ohio, Nebraska, Wisconsin, and South Dakota. Two states surveyed were Western States, namely; Utah and Washington.

TABLE XIX

SOME FACTS RELATIVE TO THE STATE SURVEY STUDIES OF CHEMICAL EDUCATION FOUND IN MAGAZINE LITERATURE 1925-1935

States Surveyed	Year Published	The Studies	Chemistry Survey	Science Survey	Method of Collecting Data	Number of Schools Surveyed
Iowa	1929	89	*		Questionnaire	72
Nebraska	1929	34	*		Questionnaire	145
Ohio	1929	60	*		Questionnaire	291
South Carolina	1934	92		*	Records and Interviews	302
South Carolina	1931	80	*		Questionnaire	300
South Dakota	1927	42		*	Questionnaire	450
Texas	1929	52	*		Questionnaire	138
Texas	1925	23		*	Questionnaire	147
Utah	1931	58	*		Questionnaire	50
Washington	1928	86	*		Questionnaire	203
Wisconsin	1928	74	*		Questionnaire	127

B. The Status of Chemical Education in Various States

The findings of the surveys of these states are not impressive.

First, let us examine some of the findings of the surveys of the Southern States.

Naudain[2] in a survey in order to determine the status of chemical education in South Carolina found that between thirty and forty per cent of the teachers had had post-graduate work; that six per cent held master's degrees; that the teaching load of teachers was not too heavy; and that the chemical equipment was good. The results of his survey indicated that chemical teaching in South Carolina was on a par with other states when similar surveys were made. Teaching conditions were satisfactory.

However, Whitton[3] in a survey of South Carolina which was published in 1934 did not find, by any means, ideal teaching conditions in that state. She states that the teachers are poorly trained; that students do not elect science; teachers teach too many sciences; and equipment is poor. The writer was forced to make the following conclusions: "That South Carolina (and possibly many other Southern States) is far behind in the teaching of science, and that one of the most crying needs of the education system of the state is greater

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[2] G. G. Naudain, Study number 59.

[3] Emma Whitton, Study number 92.

emphasis upon the need for scientific equipment and especially prepared teachers."

Oppe[4] in a survey of chemistry in Texas found that teachers were teaching too many subjects. Few of them had any work in education; most of them had five years of experience; very few had any methods in the teaching of chemistry. He expressed a general dissatisfaction with the method and materials of the chemistry course.

Entriken[5] in a science survey of one hundred forty-seven high schools of Texas found science conditions very poor. Seventy-five per cent of the teachers were teaching other subjects than science. Only 2.2 per cent of the students were enrolled in science. One-third of the schools required no science whatsoever.

We should expect to find science conditions better in the middle-west.

However, Phelan[6] found in a survey of chemistry and chemistry teaching in Ohio which was published in 1929, that chemistry teachers are not well trained; that the teaching load is heavy in the small high schools; that the students find the subject too theoretical and consequently it is not popular.

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[4] G. A. Oppe, Study number 52.

[5] J. B. Entriken, Study number 23.

[6] E. W. Phelan, Study number 60.

His data indicated that the teachers are doing a good job of teaching under the circumstances.

Rogers[7] concluded after making a survey of chemistry teaching in Wisconsin that: "When we study the data obtained on the matter of teaching load, extra-curricula activities, and the range of subjects assigned to teachers of chemistry, it seems as if the chemistry teacher is imposed upon in the amount of work that he does. Chemistry will be more effectively done when the teaching load is not more than five hours per day, including laboratory period. No teacher can do a good job when he is asked to teach five or six subjects, as the average high-school chemistry teacher does in Wisconsin."

Hendricks[8] and Chambers in a survey of chemistry teaching in Nebraska, which was published in 1929, showed that high school chemistry was not offered in a large per cent of the high schools of Nebraska; that a fair per cent of the students continued chemistry in college; that only 3.6 per cent of the students take chemistry in high-schools.

The research workers in some of the Western States did not find the status of science and chemical education very encouraging in these states. Thompson and Rantz[9] found in a study of the status of chemical education in the high schools of the state of Washington that many of the teachers majored in subjects

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[7] T. A. Rogers, Study number 74.

[8] B. C. Hendricks and J. S. Chambers, Study number 34.

[9] F. G. Thompson and F. A. Rantz, Study number 86.

other than chemistry and that there is no uniformity in subject matter.

Peterson[10] in a survey study of chemical education in fifty high schools in the state of Utah found: the enrollment in high school chemistry was low. Most of the teachers teach other subjects. Many of the teachers majored in unrelated fields of chemistry instruction. The median training of chemistry teachers in Utah High Schools is thirty-three hours. Many of the teachers have had considerable teaching experience.

C. Survey of Science Education in Several States

Curtis[11] in a very extensive article in North Central Association Quarterly, 1931-1932, gave the status of the teaching of science in the secondary schools accredited by the North Central Association. We should expect to find the status of science teaching satisfactory in these schools. However, Curtis found that in a majority of the high schools, chemistry, biology, physics, and general science were the only science offered. Many of the teachers teaching in these accredited high schools were inexperience. Most of the teachers had bachelor's degrees. Fifteen per cent of the men and 9.5 per cent of the women had master's degrees.

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[10] Hugh W. Peterson, Study number 58.

[11] Frances D. Curtis, Study number 20.

Curtis remarked: "It is somewhat surprising to find among the teachers of science in the schools of the North Central Association even so small a percentage as 1.7 per cent of the men and 2.9 per cent of the women who possess secondary school teachers of academic subjects shall be equivalent to graduation from a college belonging to the North Central Association of Colleges and Secondary Schools." According to Curtis only 4.9 per cent of the men and 10.9 per cent of the women had had practice work in the subjects they were teaching. However, many of these teachers had had considerable work in education. The teaching load and the class sizes were not excessive. Laboratory practices in these schools were found to be satisfactory. The general conclusion that one reaches from the study of Curtis is that, though, the status of science teaching in the high schools accredited by the North Central Association of Colleges and Secondary Schools is better than that found in most of the high schools of the country, there is improvement which is needed.

Hunter[12] in a questionnaire study which attempted to ascertain tendencies in the teaching of science in one thousand high schools found that general science is gaining in popularity; hygiene is entering the junior and senior high schools; biology is still offered in the tenth year; enrollment in the special sciences is small including chemistry; the science courses are

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[12] George W. Hunter, Study number 40.

more closely related than they were twenty years ago.

D. Surveys of Science Teachers

Dunbar[13] in a survey of science subjects taught by high school chemistry teachers of South Dakota, published in 1934, found that chemistry teachers of South Dakota teach a large number of subjects. He found only five teachers of South Dakota, who taught chemistry only.

Reed[14] in a survey of the preparation of science teachers in New Jersey found that they were not well prepared in subjects that they were teaching; that they had not had enough work in the teaching of their subjects; that very few general science teachers had adequate preparation to teach this subject. General science was found to rank first in the number and the size of classes; biology, second, and chemistry, third.

Zeismer[15] in a questionnaire study which attempted to ascertain the academic and professional training of science teachers in Wisconsin found that science teachers, generally, were not well prepared and that they did not pursue professional courses to any great extent beyond the requirement.

E. Science Classrooms

One of the most serious objections to the teaching of

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[13] Ralph E. Dunbar, Study number 21.

[14] Rufus D. Reed, Study number 71.

[15] Gustave Zeismer, Study number 93.

high school science is the matter of cost. This is especially true of chemistry which, no doubt, is the most expensive science taught in the high school from the standpoint of the cost of equipment and supplies. This extra cost for science is especially burdensome to the small high school. Probably this is one reason the special sciences are not offered to any greater extent than they are in the small high school.

Dr. Paul C. Packer[16] in "Housing of High School Program" shows that even in a typical large high school building the classrooms are used only 84 per cent of the available time. He states definitely that in schools having less than five hundred enrollment most of the specialized rooms such as laboratories of interchangeability of use.[17]

Jensen and Glenn[18] in order to over come some of the objections that have been made relative to the expense of science classrooms have suggested the use of a combined classroom and laboratory. These two investigators made a survey relative to the opinions of science teachers in South Dakota concerning the combination classroom and laboratory. Some of the conclusions made from this survey were: (1) the combined classroom and laboratory overcomes one of the most

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[16]P. C. Packer, "Housing of High School Program", Contribution to Education No. 159, Teachers College, Columbia University, p. 12.

[17]Ibid., p. 38.

[18]J. H. Jensen and R. E. Glenn, Study number 42.

stubborn objections to the introduction of chemistry in the small high school in which there may be only one class of ten to twenty pupils, (2) most teachers think a separate laboratory is necessary; this is impossible because, first, the floor space is limited; and second, if installed the laboratory room would be idle ninety per cent of the time.

F. Summary

The survey studies of chemical education that are found in magazine literature 1925-1935 revealed some significant facts.

The studies concerned entirely or in part, with the status of chemistry and other science teachers revealed:

1. That, as a whole, chemistry and other science teachers are not well prepared to teach the subjects that they are teaching.
2. That, as a whole, chemistry teachers and science teachers have not had much professional work in the teaching of their subject.
3. That, as a whole, chemistry and other science teachers have not had much work in education.
4. That, as a whole, chemistry and science teachers teach other subjects than science.
5. That, as a whole, the teaching load of science teachers is too heavy.

Most of the studies that were concerned with the enrollment in chemistry and other sciences revealed that the enrollment in special sciences is low, that general science is gaining in popularity so far as the number of students who elect this subject are concerned.

The research studies also show:

1. That in many schools, even those of the North Central Association, the only sciences offered are chemistry, biology, physics, and general science.
2. That in many schools chemistry is not offered because the expense is prohibitive.
3. That the teaching and laboratory methods in many schools are not the best.
4. That chemistry and science equipment in many schools are poor.
5. That the science conditions in the high schools of the North Central Association of High Schools and colleges are probably better than in most high schools of the country, but there is improvement which is needed even in these schools.

V. CONTRIBUTIONS OF RESEARCH, IN MAGAZINE LITERATURE 1925-1935, TO THE TEACHING OF CHEMISTRY

A. The Types of Studies That Treat With the Teaching of Chemistry

Table XX shows the specific and general research studies found in magazine literature 1925-1935, and the types of studies which they represent. The table shows there are six general types and their subtypes which are considered in this chapter. These six types are: (1) classroom (2) laboratory methods (3) lecture versus laboratory work (4) individual laboratory versus lecture demonstration (5) enriched teaching and (6) subject matter of chemistry. There were thirty-three studies included in the classification shown in Table XX. These studies were distributed among the types as follows: classroom methods, nine; laboratory methods, six; lecture versus laboratory work, two; individual laboratory versus lecture demonstration, four; enriched teaching, seven; subject matter of chemistry, five.

The types ranked according to the number of subtypes devoted to each are: classroom methods (1), enriched teaching (2), laboratory methods (3), subject matter of chemistry (4), individual laboratory versus lecture demonstration (5), lecture versus laboratory work (6).

TABLE XX

THE SPECIFIC AND GENERAL RESEARCH STUDIES IN THE TEACHING OF CHEMISTRY FOUND IN MAGAZINE LITERATURE 1925-1935, AND THE TYPES OF STUDIES WHICH THEY REPRESENT

Types of Studies	Specific Studies	General Studies	Number	Per Cent
A. Classroom Methods				
1. Methods of Presenting Subject Matter	(48)(79)(4)		3	3
2. Study Methods	(16)		1	1
3. Term Paper Practices	(22)		1	1
4. Sectioning	(10)(76)		3	3
5. Criticism of Teaching Methods		(41)	1	1
B. Laboratory Methods				
1. Laboratory	(12)(57)	(13)	4	4.1
2. Notebooks	(9)		2	2
C. Lecture versus Laboratory Work	(3) (54)		2	2
D. Individual Laboratory versus Lecture Demonstration	(1) (43)	(55)(70)	4	4.1
E. Enriched Teaching				
1. Visual Education	(26)(38)	(88)(11)	4	4.1
2. Science Clubs		(87)(73)	2	2
3. Activities of Science Students		(78)	1	1
F. Subject Matter of Chemistry				
1. Contents of Courses	(46)	(28)	2	2
2. Reorganization	(18)(45)(14)		3	3

B. Classroom Methods in Chemistry

1. Methods of Presenting Subject Matter

Many high school chemistry students find chemistry a very difficult subject. This is probably due to the fact that chemistry is an abstract subject. Its language and methods of chemistry to a great extent, are outside the experiences of a large number of adolescent boys and girls. Therefore, the chemistry teacher must forever be on guard to find the best methods for presenting this abstract subject. Of course the teacher should use the methods or the combinations of methods that work best for him. What has research contributed within the past ten years to the methods of classroom teaching chemistry?

Nash[1] made an experimental study in order to determine which of three methods was best in the teaching of high schools chemistry; the pupil-method, the combination-method, or the instructor-method. In the pupil-method, the pupils were allowed to work as they pleased. In the combination method, demonstrations, lectures, and laboratory work were used. In the instructor method, the instructor did the work and performed the experiments. In the final test, the mean for the instructor group was the highest. The pupil group ranked second and the combination group last.

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[1] H. B. Nash, Study number 48.

Silverman[2] attempted to determine whether intensive training was more effective than non-intensive training. One group of students met every day and covered the work in one half the time usually alloted to the course. The control group covered the work in the regular time. The intensive training yielded a higher percentage of superior grades.

Bawden[3] has tried with success and proved by means of a control group and an experimental group that the conference plan of teaching chemistry is very effective. In the conference plan, the student chooses his own textbook, problems, and materials best suited to his needs and past training. Each student progresses independently of his classmates.

2. Study Methods

Crosby[4] attempted, by means of a questionnaire, to ascertain the study habits of 170 high school students in chemistry. He concluded that a large percentage of students do not spend enough time in studying, and did not know how to study.

3. Term Paper Practices

Dunbar, Holgate, and Harkness[5] made a questionnaire study of the term paper practice in the high schools of the United

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[2]A. Silverman, Study number 79.

[3]A. T. Bawden, Study number 4.

[4]O. A. Crosby, Study number 16.

[5]R. E. Dunbar, E. H. Holgate, and J. T. Harkness, Study number 22.

States. The number of schools that required term papers was about the same as the number that did not require term papers. Most of the topics that were chosen for term papers were of real value. There were many benefits that science teachers thought were derived from term papers.

4. Sectioning of Students

What to do with the very slow students in chemistry is a perplexing problem to the high school chemistry teacher. Brown and Coons[6] found that by putting the slow students into separate classes they were greatly helped. These classes were small and the teacher could devote more time to individual students.

Another plan of sectioning was that used in the Lakewood High School, Lakewood, Ohio.[7] The students in chemistry in this high school were grouped according to intelligence and marks in previous subjects into fast, medium, and slow classes. It was proved in this investigation that students with a high index of brightness can achieve the traditional chemistry course. Students of low index of brightness have difficulty in accomplishing tasks that require more than one step.

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[6] R. E. Brown and R. R. Coons, Study number 10.

[7] R. D. Reed, C. Salter, J. Kluckholm, and R. C. Gies, Study number 69.

[8] Maude B. Scofield, Study number 76.

In an investigation of sectioning in Syracuse University it was found that high school grades in mathematics served as a fairly good guide in sectioning students; that high school chemistry grades and high school mathematics grades servered as a better guide than either alone. Tests given at the beginning of the quarter served as a good guide.

5. Criticisms of Science Teaching

Hurd[9] made an analysis of literature in order to determine the inadequacies of science teaching. Ninety-two statements of fifty-two authorities writing between 1900-1912, and one hundred and thirty-two statements of fifty-eight authorities writing between 1913-1926 constitute the source of this analysis. Many inadequacies were discovered.

The inadequacies were grouped under the following five categories which are positive statements, but which according to Hurd suggest the inadequacies:

1. Well-defined aims and objectives.
2. Well-chosen subject matter suited to the needs of the pupils.
3. Better selection and training of teachers for the job.
4. Greater responsibility and freedom of action of pupils with motivation and emphasis.

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[9]A. W. Hurd, Study number 41.

5. Methods of science used to determine future changes in the course.

The investigator found that the greatest stress has been placed on inadequacy number two, well-chosen subject matter suited to the needs of the pupils. Within recent years, the stress on this inadequacy has lessen somewhat, and we find an increased emphasis on methods of science used to determine future changes in the course.

C. Laboratory Teaching

The writer has formed the opinion, as a student of science and later as a teacher of science and from the writings of others on the problem, that many of our formal laboratory methods possess no great teaching values. Research for the past eleven years, in a large part, bears out this opinion.

1. Laboratory Methods

Carpenter[10] writing in 1926, gave an account of experiments in his classes relating to laboratory practices. Carpenter found the demonstration method succeeded as well as the individual laboratory method. He also found that students performing experiments in groups of two do not succeed as well as when they work the experiments individually.

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[10] W. W. Carpenter, Study number 12.

In these experiments he used control groups and experiments in groups.

Bowers[11] writing in the magazine, Education, in 1934, discussed an experiment for grouping of students for work in the chemistry laboratory. Bowers' findings relative to students working in pairs were different from those of Carpenter.[12] He concluded that the average student is neither benefited nor injured by working in pairs. Although, he does conclude that the weak student is benefited by working with a strong student; the strong student is not injured by being paired with a weak one. The mechanical genius, according to Bowers, is handicapped by being paired with a weak or a strong student.

Persing,[13] writing in 1929, gave the result of study of high school chemistry students in the Glenville High School, Cleveland, Ohio, in order to determine their achievement in laboratory technic. Tests were given to students who had had one year of high school chemistry. Persing did not make any definite conclusion although, he stated further research was needed along this line. He suggested that the tests be given immediately following the completion of a unit of work in chemistry.

Clem,[14] writing in 1934, gave the results of a questionnaire

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[11] W. G. Bowers, Study number 9.

[12] Study 12.

[13] K. M. Persing, Study number 57.

[14] Orlie M. Clem, Study number 13

study in which he attempted to determine current practices and opinions relative to the laboratory phase of high school science teaching in the high school of New York State. He found: a close relationship between the laboratory work and textbooks in science; the lecture demonstration method is used; well-planned field trips are conducted. In general, pupils do not work individually in the laboratory. The teachers do not make use of any new type tests.

2. Notebooks

Stubbs[15] in 1926 made an experimental study of the relative value of methods for recording laboratory notes in high school chemistry. He concluded that many of our long-used methods of recording laboratory notes are of no real value. The writings of the procedure or methods followed do not aid appreciably the memory in retaining the main facts of the experiment. The many extra hours needed by the students to write separate detailed notes, and by the instructor to correct them are not justified by the results obtained. The notes, according to Stubbs, should contain only a brief statement of the object of the experiment and answers to questions in the manual.

In the years 1928-1929, Graham[16] of New Mexico State Teachers College made a study of notebook methods that are

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[15] M. F. Stubbs, Study number 84.

[16] H. C. Graham, Study number 31.

used in the best high schools of the United States. This study included four hundred and seventy-five high schools.

The writer made a table (Table XI) whcih gives the number of affirmative and negative answers to Graham's questionnaire. It is apparent that many chemistry teachers are still using the traditional methods of recording laboratory notes. Stubbs[17] in his experiment showed that there is no advantage in the writing of extensive notes, but according to Graham's findings, 61.7 per cent of the teachers in the best high schools of the country used in 1929 this method. Only 38.3 per cent of the high schools used manuals in which students fill in the blanks. According to Graham, one teacher of chemistry had used the same notebook method for thirty-five years. Many of them had used the same notebook method for many years.

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[17] M. F. Stubbs, op., cit. p. 68.

TABLE XXI

THE AFFIRMATIVE AND NEGATIVE ANSWERS TO GRAHAM'S QUESTIONNAIRE IN HIGH SCHOOL CHEMISTRY IN THE UNITED STATES

Question	Number of Affirmative Answers	Per Cent	Number of Negative Answers	Per Cent
Do you require students to keep a notebook record of their laboratory work?	287	93.2	21	6.1
Do your require loose-leaf notebooks?	181	60.9	116	39.1
Do your use notebooks in which students fill in the blanks?	127	38.3	205	61.7
Do you require that the laboratory manual serve as a notebook?	19	Not Given	Not Given	Not Given
Are notebooks written in final form outside of the laboratory?	119	35.5	190	56.7
Are students required to leave notebooks in laboratory between the laboratory periods?	149	79.7	38	20.3
Do you require drawings in the notebooks?	260	78.1	71	21.9
Do you give a grade for the notebooks?	251	76.3	78	23.7

D. Lecture Versus Laboratory Work

What are the best ways of connecting laboratory work with classroom work? There are two investingations which have attempted to answer this question.

Bagby[18] attempted to determine the relative efficiency of three methods of correlating classroom and laboratory work. The three methods which she used were: (1) the experiment preceded the class work; (2) a one-day preview was made before the experiment; (3) all class work was completed before the experiment. She concluded that a change in the relative time of class and experiment has little effect on the average pupil.

However, Parr and Spencer[19] found in an investigation that for the total population the recitation-first method was somewhat superior. Both methods seem to work well for bright pupils, but for the duller students the recitation-first method gives better results.

E. Individual Laboratory Work Versus Lecture Demonstration

The writer does not know of any question, within recent years, that has caused as much controversy among science teachers and particularly chemistry teachers, as the question

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[18]G. Bagby, Study number 3.

[19]Rosalie M. Parr and Mable A. Spencer, Study number 54.

relative to the effectiveness of individual laboratory method versus the lecture-demonstration. What are the conclusions of researchers attempting to solve this important problem?

Anibal,[20] in 1926, conducted an experiment to determine the relative effectiveness of the lecture-demonstration method versus the individual laboratory method in the teaching of high school chemistry. There was a control group and an experimental group. The conclusions reached were: the immediate retention is as fully as adequate when the material is presented by the lecture-demonstration method as when the class is taught by the regualr individual laboratory procedure.

Knox[21] in writing in the School Review for 1927, gave the results of an experiment conducted with high school chemistry classes. His findings were similar to those of Anibal. However, he found that the lecture-demonstration, in many ways, was superior to the individual laboratory method. According to Knox, the demonstration method is equal to the laboratory method for imparting to a group of pupils a scientific attitude and training in method of attack on new problems.

Two investigators made compilations of the finding of other investigators relative to the lecture-demonstration method versus the laboratory method.

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[20] F. G. Anibal, Study number 1.

[21] W. W. Knox, Study number 45.

Reed[22] concluded after reviewing many studies relative to the two methods that the best procedures are: (1) to demonstrate in high school chemistry those experiments which explain important chemical phenomena and laws; (2) to allow students to perform experiments which give practice in handling apparatus.

One of the best summaries, according to the writer's opinion, treating with the lecture-demostration versus the individual laboratory method is found in the doctorate thesis of Payne.

Table XXII is a summary which Payne gives of typical studies comparing the lecture-demonstration and individual laboratory. The table shows that four of the investigators favor the lecture-demonstration method and two do not.[23]

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[22] R. D. Reed, Study number 70.

[23] V. F. Payne, Study number 55.

TABLE XXII

SUMMARY OF TYPICAL STUDIES COMPARING THE LECTURE DEMONSTRATION AND INDIVIDUAL LABORATORY METHODS IN HIGH SCHOOL CHEMISTRY

Studies	Conclusions	Comments
Wiley (10): Three unequaled groups, each of eight high school chemistry students.	Considered unfavorable to lecture demonstration.	Differences are small. Study has a doubtful value.
Anibal (13): Thirty pairs of high school chemistry students for one year and seventeen pairs for a second year.	Demonstration method is as effective as the individual laboratory, takes two-thirds as much time, and costs about one-fifteenth as much as the laboratory.	
Knox (16): High school chemistry.	Favorable to the demonstration method.	
Pugh (15): High school chemistry.	Favorable to the demonstration method. The advantage continues after the compared groups are united in individual laboratory work.	
Nash and Phillips (14): Second Semester high school chemistry.	Favorable to the "instructor" (laboratory) method.	
Carpenter (11): Thirty-four high school chemistry classes from schools in fourteen states.	Favorable to lecture demonstration although the results were not statistically significant.	A very valuable study conservative in conclusions.
Horton (12): High school chemistry. Manipulative skill.	Statistically significant results favorable to individual laboratory.	Open to criticism on account of the sterile demonstration method used.

F. Enriched Teaching

One of the criticisms often made of science teaching is that the students find it uninteresting.[24] What are the means by which teachers can make a science more interesting and appealing to youths? What are the devices, methods, and means, by which teachers can "enrich" their teaching? A few researches were found in periodicals from 1925-1935 that attempted to answer, in part, this important question.

1. Visual Education

J. O. Frank[25] made an analysis of students' interests in various types of slides. Many of the slides were found to possess no teaching value, but were of value because of the interest they provoke. These slides were rated highly many times by the students.

Walters[26] reported the same findings as Frank. By means of a questionnaire he found that the most interesting pictures are not the ones from which the students learn the most. Like Frank, he concluded that many times high instruction value was sacrificed for high entertainment value. Pictures were found to be more vivid than visits to plants. The students preferred the pictures to laboratory work.

An interesting series of investigations are described by

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[24] A Program for Teaching of Science, op., cit. p.

[25] J. O. Frank, Study number 26.

[26] O. Walters, Study number 88.

Brown[27] as to the relative value of motion picture or slides. These investigations were carried on in the Ridgewood High School, Ridgewood, New Jersey.

In the first investigation sixteen matched pairs of students were used. Each group of students was assembled separately. To one group was shown film slides. The instructor discussed the films as they were shown and allowed the students to ask questions. Tests were given at the completion of the showing of the film. To the second group a motion picture of the same topic was shown, no questions were asked. Tests were given at the completion of the picture. The investigator concluded from the results of the tests that the strip film is the movies' superior as a learning aid. Similar results were obtained when forty matched pairs were used instead of sixteen.

2. Science Clubs

There has been much written on high school science clubs within recent years. The investigator found two research workers treating with science clubs.

Walker[28] found from a questionnaire study of one hundred twelve high schools that all favored science clubs, if they were properly conducted and supervised. All agree that there is a place for a good science club because the teachers are

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[27] H. E. Brown, Study number 11.

[28] H. Walker, Study number 87.

pressed for time to do the amount of regular class and laboratory work in the usual course in chemistry.

Roberts[29] used another method in order to ascertain the values and functions of science clubs. He made an analysis of thirty-five separate periodical articles written on science clubs from 1914-1931. The author listed in order of the number of times mentioned by the writer of the article the items that they deemed worthy of mention. Some of these items in order of importance are: types of clubs, objectives, membership, officers, time of meeting.

3. Activities of Science Students

An analysis was made of the activities that students of science prefer in the Cass Technical High School, Detroit, Michigan.[30] The activities found that students prefer listed in order of their rank are: (1) writing reports from books in the library; (2) collecting and mounting pictures; (3) collecting material for booklet; (4) tracing outlines; (5) making collections; (6) making posters; (7) floor talk; (8) draw pictures from texts; (9) collect newspaper articles; (10) make maps.

G. Subject Matter of Chemistry

What to teach in chemistry is just as important as how to teach. Much of the subject matter of chemistry is soon

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[29]Ethel L. Roberts, Study number 73.

[30]Elizabeth G. Sichler, Study number 78.

forgotten. This is proved in a study made by Victor H. Noll.

Are we giving our students material of no consequence? Are we merely giving them facts that have no relation to their every day life? Several studies were found that, in part, attempted to answer this question, first by ascertaining the contents of the high school chemistry courses, and secondly, by ascertaining how and why these courses should be organized.

1. Content of Courses

Malan[31] in 1932 made a questionnaire study of fundamentals of chemistry taught in one hundred one high schools of the United States. His principal conclusion was: the more fundamental aspects of chemistry are taught in most schools while the more abstract aspects of chemistry are taught in fewer schools.

Garner[32] attacked the problem in another way. She made an analysis of examination question in chemistry given by various states and cities in the Middle West and East. The questions asked on these tests in order of the number asked are as follows: memory tests, use of symbols, formulas, laboratory, and commercial chemistry problems, and miscellaneous.

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[31] L. E. Malan, Study number 46.

[32] Edith Garner, Study number 28.

2. Reorganization of Subject Matter

Stevens[33] concluded as a result of the analysis of the literature in the field and a questionnaire sent to various high schools that the new course in high school chemistry is not completely college preparatory, but partly so, and adapted to the practical interests of all students.

Collier[34] has tried with success a new type of chemistry course. First, the fundamentals of chemistry are taught. Then, consideration is given to those problems which are a part of the students' daily lives. Some problems considered were: chemistry of food, clothing, shelter, and health. Collier proved by tests that the achievement is equally as good in this new type course as in the regular high school type of chemistry.

Lancelot[35] writing in North Central Association Quarterly, March 1931, described the results of experiment of teaching a reorganized unit of work in chemistry in the high schools of the North Central Association. The basis for the reorganization of this unit was an experimental unit taught in twenty high schools of the North Central Association in the spring of 1929. In the 1929 study it was found that much of the material included in the unit could be eliminated, but on the other hand much should be included. The results from the teaching of the reorganized unit, "The Relation of Chemistry to Human Health", were highly satisfactory.

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[33]Clarence P. Stevens, Study number 82.

[34]Robert Collier Jr., Study number 74.

[35]W. H. Lancelot, Study number 45.

H. Summary

In this chapter there are six types of studies that treat with the teaching of chemistry. They are: classroom teaching, laboratory methods, lecture versus laboratory work, lecture , demonstration versus individual laboratory, enriched teaching, and subject matter of chemistry.

It was shown that the largest number of research studies in the teaching of chemistry treat with classroom teaching, and enriched teaching ranked second.

In the classroom methods of teaching chemistry it was shown by research workers (1) in a method of teaching chemistry in which the instructor did all the work that better results were obtained than by two other methods; (2) that continued teaching is better than intermittent teaching; (3) that the conference plan of teaching chemistry very effective; (4) that study methods of high school chemistry students are poor; (5) that term paper practices in many schools were beneficial; (6) that the sectioning of slow students is advantageous; (7) that there are many weaknesses in the present methods of presenting chemistry; (8) two research workers disagree as to the best methods of students working in the laboatory individually or in pairs; (9) that the formal methods of recording notes in the laboratory possess no real value; (10) that many schools in the country are still using the formal method of recording laboratory notes; (11) two reasearch workers disagreed as to whether lecture should

precede laboratory or vice versa; (12) the majority of the investigators found the lecture demonstration method was preferable to the individual laboratory method; (13) two investigators found that one of the chief values of visual education is the interest it aroused; (14) that science clubs are valuable if properly conducted; (15) that students like to do work which is not of a classroom nature; (16) that the more fundamental aspects of chemistry are being taught in school; (17) that the reorganization of subject matter of chemistry is desirable and beneficial.

VI. THE CONTRIBUTIONS OF RESEARCH, IN MAGAZINE LITERATURE 1925-1935, TO TESTING AND MEASURING IN CHEMISTRY

Testing and measuring as a science in education is rather young. Within recent years, though, the seientific testing and measuring movement has progressed rapidly. The tests and measurements are increasingly valuable tools for those interested in the pedagogical aspects of science. It was shown in Chapter V that the science teacher should know what to teach and how to teach. He should know how effective his teaching is in every stage of the teaching process. He must be able to measure quickly and accurately what his class is learning. He must be able to diagnose pupils' difficulties in all stages of the learning process.

A. Types of Tests and Measurements

Frank[1] gives the following function of testing in science.

1. The teacher must use tests to measure accomplishment, as a basis for promotion and determination of standard obtained.
2. The teacher must use tests to find out what his teaching has accomplished, so that he may determine what to reteach and when to go on.

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[1] J. O. Frank, op., cit., p. 148.

3. The teacher should use tests to determine daily progress and as a means of enforcing daily preparation on the part of his students.
4. Teachers may use tests at the beginning of the school year in an attempt to gauge the ability and preparation of their students.
5. Tests are used in various types of research, such as studies which attempt to compare the value of two types of instruction.

On the basis of the way science tests may be used as given by Frank, the studies found in periodicals that related to testing and measuring in science were classified as: (1) diagnostic tests, (2) teaching tests, (3) achievement tests, (4) comparison tests.

Table XXIII shows the research studies in tests and measurement and the types of studies which they represent. The table shows that the most intensive researches in tests and measurements have dealt with diagnostic testing. There were six tests of this nature or 37.5 per cent of the total. The studies that treated with comparison ranked second. There were five tests of this type or 31.2 per cent of the studies. There were two studies each devoted to teaching tests and achievement tests, and one study that treated with the reliabilty of examination marks. There were no general studies.

TABLE XXIII

THE RESEARCH STUDIES IN TESTS AND MEASUREMENTS IN MAGAZINE LITERATURE 1925-1935 AND THE TYPES OF STUDIES WHICH THEY REPRESENT

	The Studies That Represent This Type	Number	Per Cent
Diagnostic Tests	(83) (39) (75) (5) (47) (6)	6	37.5
Comparison Tests	(67) (64) (59) (33) (32)	5	31.2
Teaching Tests	(80) (18)	2	12.5
Achievement Tests	(72) (61)	2	12.5
Reliability of Examination Marks	(36)	1	6.2
Total		16	100

B. Comparison Tests

It is believed by many that the best students major in science, and that they are usually more intelligent than the non-science students. It is also believed by many that boys, do better work than girls in science. A few research studies were found in magazine literature 1925-1935 that attempted to answer these questions.

Powers[2] and Hanske[3] attempted to determine the correlation between achievement and tests scores of students and their intelligance. Both made practically the same conclusion, namely, that the intellignece of students does not determine whether they will be successful in chemistry. Powers arrived at his conclusion by finding the I. Q.'s of beginning students in chemistry and making a comparison of the I. Q.'s with the actual achievement of students as measured by Power's general chemistry test. Most of the data for his problem was obtained from a cooperative study conducted by chemistry teacher of the North Eastern Ohio Chemistry Teachers Association.

Hanske measured the intelligence of a large group of students by the Terman Intelligence Test and compared the I. Q.'s of the students with the score which they made on the Powers Chemistry Test, Rich Test, the instructor marks, the Regents, and a composite of all.

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[2]S. R. Powers, Study Number 67.

[3]C. F. Hanske, Study Number 33.

Phelan[4] found in a study of the comparison of the students who had had high school chemistry and were enrolled in college chemistry classes that students who have had high school chemistry were no more intelligent than those who have not had chemistry.

Hanske[5] made a study of the relative performance of boys and girls in high school chemistry. He had two groups, one group of boys, and another group of girls. These two groups were paired as equally as possible. There was little difference in the intelligence of either group. The medium score made by the boys at the end of the semester was higher than that made by girls. Hanske believed that this difference was due to the fact that the boys had a better science preparation than the girls.

In a comparison of accomplishment in chemistry of students in English and American Secondary Schools, Powers[6] showed that achievement by students in English schools was inferior to the achievement by students in American schools. However, this cannot be accepted as definite and proved conclusion because the period of training of the two groups was not constant.

C. Diagnostic Tests

What are pupils' difficulties in chemistry? What kind of errors do high school chemistry students most frequently make?

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[4]E. W. Phelan, Study number 59.

[5]C. F. Hanske, Study number 32.

[6]S. R. Powers, Study number 64.

Of the six studies that represented diagnostic testing, three have attempted to answer the first question, one the last question, and one attempted to answer the question as to whether student performance in chemistry could be predicted.

Table XXIV is a summary showing the pruposes, methods, and conclusions of studies that treat with diagnostic testing. Studies 83 and 47 attempt to determine students' difficulties in chemistry. The conslusions show that the abstract phases of chemistry instruction are most difficult such as, problems, equation writing, valence, dissociation, and the atomic theory.

Attacking the problem from another angle, that is, of the errors which pupils make in chemistry on tests, Study 5 shows that pupils make more errors on tests of an abstract nature such as, writing formulae, balancing equations, and gas volume problems.

In Study 39 an attempt was made to discover whether pupils made greater progress when diagnostic tests were used in order to discover students' difficulties and when an attempt was made to correct these discovered difficulties at every single stage in the teaching process than when no such methods were used. The results point to one conclusion, that is: students make greater progress when diagnostic teaching is used.

In Study 48 an attempt was made to predict performance of students in general chemistry. The general conclusion reached was: it is possible, in part, to predict the performance of students in general chemistry.

TABLE XXIV

A SUMMARY SHOWING THE PURPOSES, METHODS, AND CONCLUSIONS OF STUDIES THAT TREAT WITH DIAGNOSTIC TESTING IN CHEMISTRY IN MAGAZINE LITERATURE 1925-1935

The Study	Purpose	Method	Conclusion
J. C. Bennett(5)	To find errors made by high school students in chemistry	Tests were given two divisions of 123 students and errors tabulated.	Most frequent errors were: writing formulae, balancing equations, gas volume problems.
Francis Howe(39)	To determine whether students make greater progress when diagnostic teaching is used.	There were four groups who were equal in all respects. Two groups were control. Two were experimental groups. Diagnostic tests were given to the experimental group in order to discover and correct difficulties.	The experimental group made better progress than the control group.
J. C. Malin(47)	To determine high school students difficulties in chemistry.	An analysis of examination papers was made and difficulties ranked	The difficulties were: valence, problems, writing formulae, writing equations.

TABLE XXIV (Continued)

H. B. Nash and N. W. Phillips (48)	To predict performance in general chemistry	Test were given to beginning students in order to determine whether they possess certain knowledges and skills which would make for success or failure in chemistry. At the end of the year the validity of the tests was determined.	It is possible to a large extent, to predict performance in chemistry.
H. R. Steward (83)	To find the difficulties of pupils in general chemistry	Tests were given to high school students who had the same amount of chemistry.	Difficult topics in order of difficulty were: problems, equation formulae, word equation, valence, dissociation, atomic theory, and fourmulae with valence.

D. Teaching Tests

According to Frank[7] teaching tests are those that aid in the teaching process; they are used to enforce daily preparation. The short answer test, the true-false test, or the ten minute written quiz can well be used for this purpose.

Spurgin[8] concluded as a result of an investigation that the short answer test is better suited for this purpose than the true-false test. He found in an analysis of the results when both types of tests were given to a group of students, that out of 151 cases where the pupils did not attempt to answer on the short answer test, one hundred were guessed right on the true-false test.

Curtis[9] found that a modified form of the multiple-response test in many ways was better than the conventional test. The modified test is described by Curtis as one in which there is a blank space left at the end of each question for the insertion of the correct answer if it is not given in the first five choices. Curtis listed the advantages of such a test as follows: it takes no more time to correct; it requires no more time to construct; it is valid; it eliminates guessing; it differentiates between the good and poor students; it has diagnostic power.

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[7] J. O. Frank, op., cit., p. 149

[8] William Spurgin, Study number 80.

[9] Francis D. Curtis and Gerald G. Woods, Study number 18.

E. Achievement Tests

There were two investigators who showed that the actual achievement of the students as measured by the tests is low. Powers[10] reported that students who have had a year or more of high school chemistry show, on the subject in college, a comparatively small progress in total attainment in chemistry as shown by the Rich tests.

Rich[11] made the same conclusion. His tests extended over a period of three years. They were given to students who had completed a year's study of high school chemistry. He stated that it appears that there are many schools in which the students do not obtain any mastery of the subject. What is obtained is quickly forgotten when the student leaves school.

F. Reliability of Examination Marks

Are the examination marks which instructors give in chemistry reliable? Horman and Hodge[12] in order to solve this problem sent the median paper in a general chemistry class to one hundred chemistry instructors. Sixty-four graded lists were returned. A wide variation was found in the evaluation of each question and in the total score.

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[10] S. R. Powers, Study number 61.

[11] Stephen E. Rich, Study number 72.

[12] T. B. Horman and Harold C. Hodge, Study number 36.

G. Summary

The largest number of research studies in the field of testing and measuring in chemistry has treated with diagnostic tests. Comparison tests ranked second; teaching tests and achievement tests ranked third; and reliability of examination marks ranked fourth.

In the comparative tests the research workers found that: (1) the intelligence of students cannot be used to predict their success in chemistry; (2) that chemistry students are no more intelligent than others; (3) that boys achieve more in chemistry than girls; (4) that the American chemistry students achieve more than the English chemistry students.

In the diagnostic tests the reasearch workers showed: (1) that it is of value to diagnose students' difficulties; (2) that abstract subject matter is the type most difficult for high school students.

The research workers also showed in their investigation: (1) that the short answer question was more reliable than the true-false tests; (2) that a modified form of the multiple-response test was in many ways better than the traditional multiple-response test; (3) that high school chemistry students achieve very little as measured by achievement test; (4) that teachers examination marks are not reliable.

VII. THE CONTRIBUTION OF RESEARCH, IN MAGAZINE LITERATURE 1925-1935, TO THE RELATIONSHIP OF HIGH SCHOOL AND COLLEGE CHEMISTRY

That the relationship of high school and college chemistry is considered important is evident by the fact that thirteen studies have appeared in magazine literature from 1925-1935 that treat this subject. In Chapter II[1] of this study it was shown that thirteen theses were written in colleges and universities on this one topic in a five-year period 1928-1933.

A. Types of Studies

Table XXV shows that the most numerous and intensive research workers in this field have dealt with the influence of high school chemistry grades on grades in college, with eight studies of this type or 61.5 per cent of the total. There were three studies that were classified as general relationship of high school and college chemistry. These represented twenty-three per cent of all studies. There were two or 15.5 per cent of the studies that were concerned with the election of chemistry by students who have studied high school chemistry. There was a total of thirteen studies all of which were specific.

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[1]See Table IV, page 20.

TABLE XXV

THE STUDIES, IN MAGAZINE LITERATURE 1925-1935, THAT TREAT WITH THE RELATIONSHIP OF HIGH SCHOOL AND COLLEGE CHEMISTRY

Types of Studies	The Studies That Represent this Type	Total	Per Cent
Influence of high school chemistry on grades in college	(37) (15) (81) (29) (35) (27) (90) (24)	8	61.5
General relationship of high school and college chemistry	(65) (91) (44)	3	23
Whether students who study high school chemistry, elect chemistry in college	(53) (19)	2	15.3

B. The Influence of High School Chemistry on Grades And Achievement in College Chemistry

There are college chemistry teachers who prefer that beginning chemistry students have no high school chemistry. They feel as if the study of chemistry in high school does not aid the student appreciably in college chemistry. There are some college chemistry teachers who feel that a study of high school chemistry is even a handicap to the beginning college chemistry study.

Table XXVI shows a summary of eight reseach studies found in magazine literature 1925-1935 that have attempted to find out what is the influence of a study of high school chemistry on the grades and achievements of students who continue chemistry in college.

There were five studies that definitely found that s study of high school chemistry was an advantage to the student who studies chemistry in college. The studies are: J. Cornog and G. D. Staddard (15), I. C. Garnad and T. B. Gates (27), L. E. Steiner (81), George A. Herrmann (35), and Paul Maurice Clasoe (29). M. S. Hines, Study 37, found a slight superiority for the student who had had high school chemistry. W. A. Everheart and W. C. Ebaugh (24) and Guy A. West (90) found that the students who had had no high school chemistry were not handicapped when they studied chemistry in college.

TABLE XXVI

A SUMMARY OF THE PURPOSES, METHODS, AND CONCLUSIONS OF RESEARCH STUDIES IN MAGAZINE LITERATURE 1925-1935, THAT TREAT WITH THE INFLUENCE OF A STUDY OF HIGH SCHOOL CHEMISTRY ON GRADES AND ACHIEVEMENT IN COLLEGE CHEMISTRY

The Study	Purpose	Method	Conclusion
M. S. Hines(37)	To determine the value of the high school chemistry course to those who continue the subject in college.	The grades of two groups of students were compared; those who had had and those who had not had any high school chemistry.	The results indicated a slight superiority in performance for the student entering college with a unit of high school chemistry.
J. Cornog and G. D. Staddard(15)	To determine the knowledge of chemistry of students who have had and those who have not had high school chemistry	Tests were given to all freshmen. The grades on a chemistry test of those who had had and those who had not had high school chemistry.were compared.	Students who had had high school chemistry made the superior grades.
I. C. Garnad and T. B. Gates (27)	To determine the influence of a previous study of high school chemistry on the students' record in college	The calculations from this study were made from the registrar's office of the university.	Students who had had high school chemistry made higher grades.

TABLE XXVI (Continued)

L. E. Steiner(81)	To determine the contribution of high school chemistry toward success in college chemistry	Grades of equal groups of students were compared. Those who have not and those who have had high school chemistry	Students who have had high school chemistry stand a better chance of making good grades than those without such preparation
W. A. Everheart and W. C. Ebaugh(24)	To determine which group make the better grades: those who have had high school chemistry or those who have not had high school chemistry.	Grades for two groups of students were compared.	Having had preparatory chemistry is no means a guarantee of success in college chemistry. A beginning student may pass who has not had high school chemistry.
G. A. West(90)	To determine the influence of high school chemistry on grades in college chemistry.	Grades of students who have had high school chemistry and those who had not had were compared.	The number of unites of high school science is of less importance for success in chemistry than are some other factors.
George A. Herrmann(35)	To determine whether high school chemistry influences the student's grades made in college.	The grades of students who had had chemistry were compared with those who had not had chemistry.	The study of high school chemistry course is at least advantageous to the majority of students who study chemistry in college.

TABLE XXVI (Continued)

P. M. Glasoe(29)	To evaluate the influence of high school chemistry on the grades of first year college chemistry.	Tests given to section numbering 80 each. Twelve tests were given.	The results point to one fact: students who have had high school chemistry achieve more than those who have not.

C. Some General Relationships of College and High School Chemistry

There was found a group of three interesting studies from the standpoint of the findings that treat with the general relationships of high school and college chemistry.

Koos[1] attempted to determine the overlapping in high school and college by an analysis of the content of the courses. According to Koos research workers have been more active in determining overlapping in high school and college chemistry than in any other field. It was found that there was considerable overlapping in the first year college chemistry and high school chemistry.

Powers[2] found that the high school students entering college chemistry classes had forgotten much of their high school chemistry. He concluded that the specific information about subject matter in high school chemistry is rapidly forgotten.

D. The Election of Chemistry in College by Students Who Have Studied Chemistry in High School

Whether college students who have studied high school chemistry elect college chemistry is an interesting question, that two investigators have answered.

Both Otto[3] and Dunbar[4] found that students who have studied

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[1]L. B. Koos, Study number 44.

[2]S. R. Powers, Study number 65.

[3]Cliff R. Otto and Mabel C. Inlow, Study number 53.

[4]Ralph E. Dunbar and Elgie B. Coacher, Study number 19.

high school chemistry elect a greater extent college chemistry than those who have not had high school chemistry. Otto made a study of 906 graduates of a state teachers college. He found that fifty per cent of the students who took chemistry in high school took it in college.

E. Summary

The research studies that have attempted to determine whether a study of high school chemistry has any influence on grades and achievement in college have, almost without exception reached one conclusion, that is, a study of high school chemistry influences the grades and achievements of students who study chemistry in college. Other research workers have found relative to the relationship of high school and college chemistry that (1) there is an overlapping between the first year college chemistry and high school chemistry; (2) beginning chemistry students in college had forgotten a large part of their high school chemistry; (3) students who have studied high school chemistry elected this subject in college to a greater extent than those who have not had high school chemistry.

VIII. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study has been to make a comprehensive survey of pedagogical researches in the field of chemistry for a ten-year period 1925 to 1935. This problem was attacked in two ways. First, a survey was made of theses and studies made by the Research Divisions of Colleges and Universities, 1928 to 1933 and secondly, a survey was made of research in magazine literature from 1925 to 1935.

In a survey of research studies from 1928 to 1933, it was found that one hundred twenty studies were made. A vast majority of these studies was sponsored by the universities; a small number was sponsored by teachers colleges and liberal art colleges. The number of studies sponsored by Research Divisions of city school systems was almost negligible. Probably the reason why so few studies were sponsored by teachers colleges is because of the fact that many teachers colleges do not have graduate schools. The great majority of the studies was made for the master's degree. Very few of these were published in any magazine. This finding is significant, in that, a vast majority of the theses written are not available, to any great extent, to individuals outside the institutions in which they are written.

If the nature of the research studies made for degrees and those made by Research Dividions of city school systems and universities is compared with studies published in magazines,

significant facts are revealed. A large number of the studies that are published in magazines is made by those affiliated with the universities. The studies made by universities and colleges and Research Divisions of city school systems were classified accoring to types and ranked according to the number of studies devoted to each type. The first five are: (1) tests and measurements, (2) analyses of chemistry laboratory manuals and textbooks, (3) classroom methods of teaching chemistry and other science, (4) relationship of high school and college chemistry, (5) state surveys of chemistry teaching. The first five types of studies found in magazine literature, classified and ranked in the same way, are: (1) tests and measurments, (2) relationship of high school and college chemistry, (3) state surveys of chemistry, (4) classroom teaching, (5) enriched teaching.

1. Tests and measurements ranked first in the first group and first in the second.

2. Analyses of chemistry laboratory manuals and textbooks ranked second in the first group; this type was not found in the second group.

3. Classroom methods of teaching chemistry ranked third in the first group and fourth in the second group. Relationship of high school and college chemistry ranked fourth in the first group and second in the second.

4. The state surveys of chemistry teaching ranked fifth in

the first group and third in the second.

5. Enriched teaching ranked fifth in the second group; it was not found in the first.

The above facts are significant in that they indicate along what lines and the extent to which pedagogical research in chemistry has been directed.

In Chapters IV, V, VI, VII, the contributions of research in magazine literature in 1925 to 1935 to the status of chemical education, to the teachers of high school chemistry, to testing and measuring in high school chemistry, and the relationship of high school chemistry and college were respectively considered.

Relative to the status of chemical education, research workers have found, almost without exception, that chemical education is very unsatisfactory. The prospective science teacher is not receiving the training in college that will fit him to teach his subjects. Schools are not receiving enough money for seience equipment; a varied program of science is not offered; and above all the science courses are not adapted to the needs and interest of the students.

Many research studies were found that treated with methods of teaching chemistry. If all studies of this nature are considered as a group, it is evident that this phase of chemistry instruction has been given more attention than any other.

The best method of teaching, of course, depends on the teacher. Though research workers may prove in certain instances

that one method is preferable to another, that is not to say that in all cases it is. The objectives of the course, the needs of the students, the personality of the teacher are factors that should be considered in the selection of any method. The fact that studies proved that a large part of what students learn in high school chemistry is rapidly forgotten should be taken into consideration in determining what to teach. No longer do we believe in the disciplinary aim of teaching chemistry. No longer should the chemistry courses be preparatory courses for college. These should be also taken into consideration in determining contents and reorganization of chemistry and science courses.

In the chapter treating with the contributions of research in magazine literature to tests and measurements it was shown that testing is of great value. Of course the teacher must be familiar with the techniques of testing. The implication is that science teachers must be trained in this field.

In every stage of the teaching process the teacher should use tests as a teaching device to check his results; to diagnose pupils difficulties; and to determine how much the students have achieved. It is indicative that from the number of studies devoted to testing and measuring, as revealed in this study, that this is one of the major trends in chemistry instruction.

A large number of research studies have been made relative to the relationship of high school chemistry and science and college chemistry and science. In view of the fact that studies

have proved that students who study chemistry in high school are benefited thereby, we should offer courses in high school chemistry if possible for those students who will continue the subject in college. Though the students are benefited by a previous study of chemistry when they study college chemistry, the high school chemistry courses should not be college preparatory because the great majority of students will not attend college and only a small number of those who do will study chemistry.

Though a survey of pedagogical research in chemistry in magazine literature for the past ten years has shown many inadequacies of chemistry and science, there is much that is encouraging that is shown. This study shows that we have begun to attack the problems of pedagogical science in a scientific way.

IX. APPENDIX

A. Annotated Bibliography

1 Anibal, F. G., "Comparative Effectiveness of the Lecture-Demonstration and Individual Laboratory Method", Journal of Educational Research, 13:355-56, May, 1926.

This is an experimental study to determine the effectiveness of the lecture-demonstration and individual laboratory method of teaching of high school chemistry. There was a control group and an experimental group. The findings of the experiment are: the immediate retention is fully as adequate when the material is presented by the lecture-demonstration method as when the class is taught by regular individual laboratory procedure. The lecture-demonstration method resulted in better immediate retention.

2 Applegarth, L. W., "Science Heads", School Science and Mathematics, 32:944-47, 1932.

This is a questionnaire study to determine status of science department heads in the high schools of six states.

3 Bagby, G., "The Correlation of Laboratory and Classroom in the Teaching of High School Chemistry", Journal of Educational Research, 19:336-40, May 1929.

This is an experimental study which attempts to compare the relative efficiency of three methods of correlation classroom and laboratory work in the teaching of high school chemistry. By method (0) the experiment preceded to class work; by method (1) one day preview of the topic was made before the

experiment; by method (2) all class work was completed before the laboratory period. It seems that a change in the relative time of class and experiment has little effect upon the pupil.

4 Bawden, A. T., "The Conference Plan of Teaching General Chemistry", Journal of Chemical Education, 11:618-19, Nov. 1934.

In this articles the author describes the conference plan, its operation, and its advantages. Under the conference plan the student, with the advise of the teacher, selects the text-book and type of course best adapted to his previous training and future needs. Each student progresses independently of his classmates. Mastery of each unit of subject matter is acquired. This cultivates the habit of independent study so essential in advanced work. It offers few opportunities for cheating.

5 Bennett, J. C., "A Study of Pupil Errors in Chemistry", Journal of Chemical Education, 2:760-770, 1925.

This is a study of pupil errors in chemistry in classes of East High School, Cleveland, with two divisions of 12B chemistry numbering about fifty-five boys and girls. It was found that great difficulty was experienced and error made in the writing of formulae, balancing equations, and in gas volume problems.

6 Bennett, Julia C., "A Study of Pupil Errors in Chemistry", Journal of Chemical Education, 4:45-57, 1927.

The author investigates the need in chemistry teaching. Our great need in the field of chemistry teaching is investigation leading to evaluation of subject matter and methods

of presentation of subject matter, so that we may, by scientific selection of the content of our chemistry course and by the improvement of teaching technique, achieve more worthy results than our reward at present.

7 Bergen, L. M. & other, "Objectives of Science Teaching", School Science and Mathematics, 31:550-60, May 1931.

The author lists a large number of specific objectives. In ranking the objectives more emphasis was placed on scientific thinking, attitudes, etc., than on specific scientific knowledge. The kind of knowledge most important is that which would give an insight into the nature and organization of the environmnet.

8 Bothe, A. A., "An Analysis of High School Tests in Chemistry", Journal of Chemical Education, 2:785-92, 1925.

An analysis of high school text is made in order to determine the amount of space devoted to various phases of subject matter. The conclusions readed were: theories and their examples are presented inductively; important phases of subject matter are not repeated often enough; the first chapter is usually definition type; no definite plans for introducing theories, laws, and principles were followed.

9 Brown, F. E. & Coons, "Treatment of Students Earning Low Grades", Journal of Chemical Education, 11:579-81, Oct, 1934.

This is an investigation which attempts to ascertain the best method and the results of sectioning students earning low grades in chemistry. Sectioning of students who make low grades was found to be advantageous. Each deliquency

remains a separate problem, involving a personality and a deficiency, both of which must be considered.

10 Bowers, W. G., "Grouping Students for Work in the Chemical Laboratory", Education, 25:429-38, 1925.

This problem has been in the mind of the writer because his experience has been, for the most part, in teacher training institutions. He justifiably concludes that: the average strong students are neither benefited nor injured by working in pairs. The average weak students are benefited by working together, the strong students are not injured by being paired with weak ones, but the weak students are benefited by working with the strong ones. Only the mechanical genius is handicapped by being paired with another student and seems to make no difference whether the other student is strong or weak.

11 Brown, H. E., "Motion Picture or Film Slide?" School Science and Mathematics, 28:517-26, 1928.

In this study two investigations were made. From the first investigation, it is concluded that the film slide, with the greater exchange of comment that it allows, proved the better. From the two investigations it is proved that for much of learning associated with still mental pictures the strip film is the movie's superior as a learning aid.

12 Carpenter, W. W., "A Study of the Comparison of the Different Methods of Laboratory Practice on Basis of Results", Journal of Chemical Education, 2:798-805, 1926

The author compared different methods of laboratory practice on the basis of results obtained on tests of numerous classes

of high school chemistry. The results of the experiment point to the conclusion that the majority of high school laboratory chemistry classes, taught by demonstration method, succeed as well as when they perform experiment individually. The majority of the students performing experiments in groups of two do not succeed as well as those performing them individually. The difference may not be great enough to warrant extra expense.

13 Clem, Orlie M., "The Laboratory Technique in Secondary Science Teaching", School Science and Mathematics, 23:603-0, 1934.

This is a questionnaire study to determine current practice and opinion relative to the laboratory phase of high school science teaching in the high schools of New York State. Some of the findings are: a close relationship exists between the textbook and the laboratory working in science; the lecture demonstration method is used; well planned field trips are commonly used to supplement the classroom work; in general, pupils do not work individually in the laboratory; less than half the teachers make use of any new type tests.

14 Cornog, J. & G. D. Staddard, "The Chemistry Training of High School and College Students", Journal of Chemical Education, 6:85-92, Jan. 1929.

Both chemistry aptitude and chemistry training examinations were given students beginning their course in college chemistry. The results imply that the frequently expressed idea: freshman instructors would prefer to teach chemistry to students who

have never dabbed in the subject in high school" is not warranted by the grades these students make. It is unsatisfactory to segregate students who have had chemistry.

15 Crosby, O. A., "Investigation of the Study Methods Used by High School Chemistry Students", Journal of Chemical Education, 7:687-8, May, 1930.

This is a questionnaire study of the study habits of 170 high school students in chemistry in Detroit in order to ascertain their study habits. The students have no regular method of studying chemistry. Too little time is spent in study by most students. Most students think the laboratory exercises helpful understanding the text. The main conclusion of this investigation is: "that it is a matter of 'how to study' as much as merely as the matter of 'study'".

16 Curtis, Francis D., "A Study of the Vocabulary of Scientific Articles Appearing in Daily Newspapers", School Science and Mathematics, 26:872-88, 1926.

In a study of the vocabulary of scientific articles appearing in daily newspapers the author used 630 articles of miscellaneous content. His findings are: there is no apparent relation between the size of the circulation or national importance of six newspapers and the percentage of scientific terms which appear in the miscellaneous scientific articles of the issues studied. The percentage of "uncommon" words found in the miscellaneous scientific articles is small, being on the average only 3.6 per cent. The respective percentages of "uncommon" words appearing in these miscellaneous scientific articles are approximately equal.

17 Curtis, Francis D. and Gerald G. Woods, "A Study of a Modified Form of the Multiple-Response Test", Journal of Educational Research, 18:211-19, 1928.

This is to determine some of the relative merits of the conventional multiple-response test having five choices, as compared to the modified form of this test. It is reasonable to conclude that this modified form is more difficult than the conventional multiple response. It is at least as good in a number of respects and better in several respects.

18 Dunbar, Ralph E. and Coacher, Elgie B., "A Study of High School Chemistry Students Electing Chemistry in College", School Science and Mathematics, 32:675-88, 1932.

The findings indicate that there is a greater tendency for high school seniors with credits in chemistry to elect chemistry in college than it is for those without credits in high school chemistry.

19 Dunbar, Ralph E., "Subjects taught by high school Chemistry Teachers of South Dakota", Journal of Chemical Education, 11:879-20, Sept. 1934.

The data for this article was obtained from official reports and records on file in the office of the South Dakota Department of Public Instruction at Pierre: in South Dakota it is not desirable to prepare high school teachers to teach chemistry alone. The students who plan to teach chemistry should have minors in mathematics, biology, and physics if possible as these subjects are most frequently taught in conjunction with chemistry. Other subjects often taught by the chemistry teacher are history, commerical arithmetic, economics, geography, commercial law, home economics, bookkeeping, music,

Latin, and English. Nine-tenths of the chemistry teachers of South Dakota are men. Twenty-three and three tenths of the four-year accredited high schools of South Dakota teach chemistry. Only five of the chemistry teachers of South Dakota teach chemistry only.

20 Dunbar, R. E.; Holgate, C. H., and Harkness, J. T., "Term Paper Practice in the Teaching of High School Chemistry in the United States", Journal of Chemical Education, 5:1440-6 Nov. 1926.

This is a questionnaire study of term paper practices in teaching chemistry in the high schools of the United States. In all the schools requiring term paper, industrial topics were used and household topics were next in popularity. Fifty-two per cent of the schools required term papers written. Forty-seven per cent did not require term papers written. Seventy-four per cent required oral reports, and twenty-six per cent did not require oral reports. There were many benefits that science teachers thought were derived from term papers.

21 Entriken, J. B. and Hodge, F. C., "A Texas High School Science Survey", Journal of Chemical Education, 2:199-207, 1925.

From this survey it is shown that: one-third of all schools require no science whatever. Twenty-two per cent of all students enrolled in science were taking but three different courses. Fifteen per cent of the teachers are teaching other subjects. Most of the teachers were degree holders.

22 Everheart, W. A. and Ebaugh, W. C., "A Comparison of Grades of Students Who (a) have had and (b) have not had High School Chemistry", Journal of Chemical Education. 2:770-775, 1932.

In this study the grades for two groups of students were compared: those who had had high school chemistry and those who had not had high school chemistry. The conclusion reached was

that having had preparatory chemistry is by no means a guarantee of success in college chemistry and the handicap of not having had preparatory chemistry will not necessarily condemn a beginning student to fail.

23 Fay, Paul J., "The History of Chemistry Teaching in American High Schools", Journal of Chemical Education, 8:1533-1556, Aug. 1931.

This is an examination of the literature and souce material in order to trace the development od chemistry teaching. It was found that during the first three quarters of a century chemistry teaching was superficial but rather practical. The period was followed by one in which the laboratory tended to dominate. Since about 1910 the study revealed that there has been evident trends toward the development of social objectives towards greater emphasis on the practical aspects, and towards a better adaptations of the need of the pupils.

24 Frank, J. O., "An Experiment in Visual Education," Journal of Chemical Education, 10:90-91, 1933.

An analysis of students' interest in various types of slides used in chemistry courses. The findings indicate that in many cases the slides are of no value or aid in teaching chemistry. One of the greatest values resulting from the use of slides lies in the interest they provoke. Some slides which seemed to have little teaching value were rated highly by the students because of the interest they provoke.

25 Garnad, I. C. and Gates, T. B., "High School Chemistry and the Students Record in College Chemistry", Journal of Chemical Education, 6:514-17, 1929.

The calculations made in this study were made from the registrar's office of the university. If students are arranged in the familiar groups denoted variously as A, B, C, D, then the differences shown are almost sufficient to place the average student who has had high school chemistry one group higher than the one who has not had such a course.

26 Garner, Edith, "A Study of Chemistry Examination Questions Given by Various States and Cities in the Middle West and East", School Science and Mathematics, 27:140-43, 1927

This is a study of examination papers in order to determine the type of chemistry taught in the various states and cities of the middle west. The questions asked on these tests in order of the number asked are as follows: memory tests (define terms); use of symbols, formulas, etc,; laboratory, commercial, and industrial chemistry problems; miscellaneous.

27 Glasoe, Paul Maurice, "Residue of High School Knowledge Utilizable in College Chemistry", Journal of Chemical Education 10:571-574, Sept. 1933

This is an investigation to evaluate the influence of high school chemistry on the grades in first year college chemistry. The experiment was conducted with sections numbering about eight each; twelve tests were given during the second semester. The results point to one fact. Students who have had high school chemistry schieve more than those who have not had high school chemistry.

28 Glenn, E. R., "An Investigation of the Types of Classrooms for Chemistry and Other Sciences in the Small High School", Journal of Chemical Education, 6:634-64, April, 1929.

From questionnaire studies and personal visits it was found that the combination laboratory and classroom as proposed in this investigation offers numerous advantages.

29 Graham, H. C., "Notebook Methods in High School Chemistry", Journal of Chemical Education, 7:1122-24, May, 1930.

This is a questionnaire study to determine what notebooks methods are being used in the best high schools of the country. The data indicated that the requirement of only brief notes is general.

30 Hanske, C. F., "Sex Difference in High School Chemistry", Journal of Educational Research, 23:412-26, May, 1931.

This is an investigation to study the relative performance of boys and girls in high school chemistry. Both groups were paired as equally as possible. From the results of tests it was shown that there is no great difference in intelligence of boys and girls. The boys had a better science preparation. The medium scores made by the end of the semester was higher for the boys than that made by the girls.

31 Hendricks, B. C, and J. S. Chambers, "Chemistry Teaching in Nebraska", School Science and Mathematics, 29:138-41, 1929

This is an investigation to ascertain some facts relative to chemistry as taught in Nebraska high schools and colleges. The findings indicate: high school chemistry is not offered in allarge per cent of high schools in Nebraska; a fair per cent of high school students continued chemistry in college; the chief argument against high school chemistry is the cost.

32 Herrmann, George A., "An Analysis of Freshman College Chemistry Grades with Reference to Previous Study of Chemistry", Journal of Chemical Education, 8:1376-86, July, 1931

This study attempts to determine whether high school chemistry influences the students' grade obtained in college. The finding indicate that the study of high school chemistry course, at least, in a majority of the cases, is advantageous to the student who enrolls in college chemistry.

33 Horman, T. B. and Hodge, Harold C., "A Study of the Reliability of Examination Marks in General Chemistry", Journal of Chemical Education, 8:2071-78, Oct. 1931.

The research worker sent the median paper in general chemistry to one hundred instructors in general chemistry. Sixty-four graded lists were returned. A wide variation was found in the evaluation of each question and in the total score.

34 Hines, M. S., "Of What Value is the High School Course in Chemistry to Those Students Continuing the Subject in College?" Journal of Chemical Education, 6:697-707, 1929.

These results indicate a slight superiority in performance as shown by grades for the student entering college with a unit of high school chemistry. The facts were got from a college which separates college chemistry students into two groups: one requiring and one not requiring a unit of high school chemistry.

35 Hopkins, B. S. and Dawson, H. G., "Visual Education in Elementary College Chemistry", School Science and Mathematics, 32:353, 1932.

The experimenters believe that they can draw no definite conclusions because their experience has been too limited. They affirm, however, their faith in the educational value of motion pictures and express their belief that visual education will furnish a valuable method for the training of the youth of the future.

36 Howe, Francis W., "Diagnostic Teaching of Chemistry", School Science and Mathematics, 34:709-13, 1934.

In the beginning classes of chemistry students used in this experiment, two groups constituted the control group; two other groups the experimental group. The control groups were taught the traditional way. In all stages of the teaching of the experimental groups, diagnostic tests were used to discover and correct students' difficulties. The experimental group made greater progress than the control group.

37 Hunter, George W., "Science Sequence in the Junior and Senior High School", School Science and Mathematics, 33:214-245, 1933

This is a questionnaire study which attempts to ascertain tendencies in the teaching of science in one thousand high schools. Some of the tendencies are: general science is growing in popularity; hygiene is entering the junior and senior high schools; biology is still generally offered in the tenth year; physiography is decreasing in importance; enrollment in the special sciences is rather small including chemistry; the science courses are more closely related now than they were twenty years ago.

38 Hurd, A. W., "Present Inadequacies and Suggested Remedies in the Teaching of High School Science", School Science and Mathematics, 28:637-39, 1928.

This is an attempt to discover what authortative writers on the subject believe to be inadequacies in the teaching of high school science. Ninety-two statements of fifty-two authorities writing between 1900 and 1912, and one hundred thirty-two statements of fifty-eight authorities writing between 1913 and 1926 constitute the sources of this analysis. Some of the

inadequacies found are in order of their importance: poorly defined aims and objectives, poor training of teachers for particular jobs, lack of scientific methods for determining future changes in courses.

39 Jensen, J. H., "High School Science Survey of South Dakota", Journal of Chemical Education, 4:897-904, 1927

This is an investigation made from questionnaires and reports of superintendents of public instruction with a view to formulationg suggestions indication how science teaching in this state might be placed upon more rational basis than it is at the present. The following would help: a carefully planned course of study for science teachers in summer school; a high school manual with suggested plans and time schedules; clearing house to furnish teachers with help in ordinary equipment.

40 Knox, W. W., "The Demonstration Method Versus the Laboratory Method of Teaching High School Chemistry", School Review, 25:376-86, 1927.

In an investigation of the advantages of the demonstration method and the laboratory method, it was found that: the demonstration method is superior to the laboratory method in teaching mentally heterogeneous groups of pupils for the purpose of immediate retention of subject matter in high school chemistry. Demonstration method is better suited for presentation of information for relatively permanent retention. It is equal for imparting to a group of pupils a scientific attitude and training in a method of attack on new problems. The demonstration method provides superior opportunity for a adaptation to individual differences in mental ability. The

laboratory method is slightly superior to the demonstration so far as providing knowledge and method of attack is concerned.

41 Koos, L.V., "Overlapping in High School and College", Journal of Educational Research, 11:322-330, May, 1925.

The results of the study show that chemistry is the only one of the college sciences in which there is any recognition of overlapping. There is, thus, an all too common disregard in the college of what the student has compassed in his period of high school training.

42 Malan, L. E., "Brief Survey of the Mechanical Fundamentals of Chemistry Taught in the United States", School Science and Mathematics, 32:149-55, February, 1932.

This is a questionnaire study to determine the fundamentals of chemistry taught in 101 schools. The more fundamental aspects of chemistry are taught in most schools, while the more abstract aspects of chemistry are taught in fewer schools.

43 Malin, J. E., "A Diagnostic Study of Students' Difficulties in Chemistry and the Effects of Application of Remedial Measures", Journal of Chemical Education, 5:208-17, 1928

This is an analysis of students' difficulties in chemistry given to high school students in Sworthmore High School, Sworthmore, Pennsylvania. The kinds of difficulties met in Sworthmore High School chemistry courses can be classified under two general headings: "information" and "tasks". Information involves memory work, and tasks involves memory and reasoning. The tasks found difficult were: valence problems, naming formulas, writing equations.

44 Nash, H. B. and M. W. Phillips, "A Study of the Relative Value of Three Methods of Teaching High School Chemistry", Journal of Educational Research, 15:371-79, 1927.

This is an experimental study to determine which of three methods is the best in the teaching of high school chemistry: the pupil method, the combination method, or the instructor method. In the pupil method the pupils were allowed to work as they pleased. In the combination method both demonstrations, lectures, and laboratory work were used. In the instructor method the instructor did the work and performed the experiments. In the final test the mean for the instructor group was highest; the pupil group ranked second; the combination group was last.

45 Nathonson, Joseph, N., "Commercial Processes in High School Chemistry", Journal of Chemical Education, 26:633, 1926

This is a textbook analysis to determine the commercial processes found in five high school chemistry texts. Over fifty commercial processes were found in chemistry textbooks. The processes were classified as essential, very important, important and interesting, This study showed that textbooks are not giving as much space and emphasis to the really important processes as they are to the less important processes.

46 Naudain, G. G., "Administrative Study on the Teaching of Chemistry in the Secondary Schools of South Carolina", Journal of Chemical Education, 9:550-64, 1931

This is a questionnaire study to determine the status of the teaching of chemistry in the state of South Carolina. Detailed questions were asked of the secondary school teachers concerning the schools, the class, and the teacher. The results of the survey were favorable and placed the teaching of chemistry

on a par with other states where similar surveys were made.

47 Nuser, Arlee, "A Study of Chemistry Found in Agricultural Periodicals", School Science and Mathematics, 26:471, 1926

This is a study to determine the knowledge of chemistry necessary for an individual who is to read intelligently agricultural periodicals. A study was made of three agricultural periodicals of widest circulation. The study included issues of ten years' publication. The analysis showed that there is a chronological increase in the use of chemistry in agricultural periodicals.

48 Oppe, G. A., "Status of Chemistry in Texas High Schools", Journal of Chemical Education, 6:1748-58, 1929.

This is a survey of 138 schools to determine status of chemistry in respect to number of schools offering subject and the number of pupils studying it. The following facts are outstanding: a general dissatisfaction with the materials and methods of the chemistry course; a need for courses in the teaching of the various branches of science; teachers still required to handle too many subjects, especially in the small high school; a lack of preparation of students before taking chemistry; the tendency to introduce outside material into the course to make chemistry more effective.

49 Otto, Cliff R. and Mabel Claire Inlow, "Do Students Who Study Chemistry in High School Elect that Subject in College?" School Science and Mathematics, 30:292-4. March, 1930.

This is a study of 906 degree graduates of a state teachers college. It was not shown conclusively that students

in this institution who have studied chemistry in high school are more likely to elect courses in college chemistry than those who have not received instruction in chemistry in high school. Fifty per cent of the students who took chemistry in high school took it in college.

50 Parr, Rosalie M. and Mable A. Spencer, "Should Laboratory or Recitation Have Precedence in the Teaching of High School Chemistry?" Journal of Chemical Education, 7:571-587, March 1930.

In this study two groups of students were used. One group was allowed to work in the laboratory before discussion and the other group had discussion before laboratory. The calcium unit was studied by both groups. The findings were: for the total population tested the recitation first method is somewhat superior to the laboratory first method of teaching. A teacher's preference must have some influence upon his success in teaching by experimental procedures. Both methods seem to work well for bright pupils. For duller students the recitation first method gives better results.

51 Payne, V. F., "The Lecture Demonstration and the Individual Laboratory Method Compared", Journal of Chemical Education, 9:932-39, 1932.

This is a study that compares the findings of an experiment treating with the lecture demonstration and the individual laboratory methods of teaching chemistry. The majority of the studies reveals that the individual laboratory method is not functionning.

52 Persing, K. M., "Present Specific Objectives in High School Chemistry", Journal of Chemical Education, 6:1958-76,1929

This is a questionnaire study. It indicated a lack of qualitative and quantitative investigations of the content of high school courses of study in chemistry.

53 Persing, L. M. "Testing Laboratory Technique in High School Chemistry", Journal of Chemical Education. 6:1321-30, 1929

Tests were constructed and administered students who had had one year of high school chemistry. Results do not warrant definite conclusions. They would indicate that it is possible to measure laboratory technique as a product of laboratory practice.

54 Peterson, Hugh W., "Status of Chemistry Education in Utah High Schools", Journal of Chemical Education, 8:2079-86, October, 1931.

This is the report of a questionnaire study indicating the prevailing conditions and practices in general in Chemical Education in Utah High Schools. The enrollment in high school chemistry was found to be low. Many of the teachers majored in unrelated fields of chemistry instruction. The median training of the chemistry training of teachers in Utah High School is thirty-three hours. Most of the teachers have had considerable teaching experience.

55 Phelan, Earl W., "Are Chemistry Students More Intelligent than Others?" Journal of Chemical Education. 6:630, Nov. 1934

A frequency distribution of I. Q. scores was made. These results strengthen the belief that the study of chemistry in high school gives the students a real advantage in a common freshman course in college.

56 Phelan, E. W., "Status of Chemistry and Chemistry Teaching in Ohio High Schools", Journal of Chemical Education, 6:2196-202, 1929.

The questionnaire method was used to determine the status of chemistry and chemistry teaching in Ohio high schools. The inexperienced teacher must start out in small school where he has to handle several subjects. Those who have studied chemistry seriously either become principals or graduate to city high schools, where equipment is usually adequate and the teaching load is not so great. The average student finds the subject too theoretical. Teachers are trying to bring the subject in range of student comprehension. The suggestion has been made by several that college preparatory students be separated from the rest, and that wherever possible different courses be taught the two groups.

57 Powers, S. R., "Achievement in High School Chemistry--an Examination of Subject Matter", School Science and Mathematics, 25:53-61, 1925.

This is a report of the results of various tests given to find achievements of pupils in chemistry. Pupils who have had a year or more of high school chemistry show, on continuing the subject in college, a comparatively small progress in total attainment in chemistry, as shown on the Rich Tests. Figures indicate that the traditional course in "general chemistry", required of those who offer chemistry at entrance, is far from being highly efficient in producing increase of attainment in the subject.

58 Powers, S. R., "A Comparison of Accomplishment in Chemistry of Student in English and American Secondary Schools", Journal of Chemical Education, 4:1505-14, 1927.

Terman Tests were used for the investigation. This report is not adequate basis for conclusion that achievement in chemistry in English secondary schools is inferior to the achievement in American schools when the period of instruction is constant.

59 Powers, S. R., "How Long Do Students Retain What They Have Learned From High School Chemistry?" Journal of Chemical Education, 2:174-180, 1925.

This study is concerned with a test given freshmen entering the University of Minnesota who had studied chemistry in high school. The conclusion is that specific information about subject matter of high school chemistry is rapidly forgotten.

60 Powers, S. R., "Some Problems of Curriculum and Method of Instruction in High School Chemistry", Journal of Chemical Education, 2:998-1007, 1925.

This is a compilation of the objectives of the various phases of chemistry instruction, drawn from reseach studies in the field. The objectives considered were: the knowledge aim and the preparatory aim.

61 Powers, S. R., "The Correlation between Measures of Mental Ability and Measures of Achievement in Chemistry", School Science and Mathematics, 28:981-7, 1928

Most of the data for the solution of this problem was obtained from a cooperative study conducted by chemistry teachers of North Eastern Ohio Chemistry Teachers Association. The I. Q.'s of a group of students was first determined. They were then given Powers General Chemistry Test at the end of a

semester of chemistry. The findings indicate that intelligence as measured by intelligence tests is a factor of success, but within the range of ability of the students tested it was not important.

62 Powers, S. R., "A Vocabulary of Scientific Terms for High School Students", Teachers College Record, 28:220-45, 1926

The result of this study is a vocabulary of the scientific terms. Chemistry textbooks are largely the product of gradual evolution and like many things in biological evolution, this has not resulted in perfect adaptation to existing needs.

63 Powers, S. R., "The Vocabularies of High School Science Textbooks", Teachers College Record, 26:362-92, 1925.

In preparing these lists of "uncommon" words used Thorndike was followed with but slight modification. It was found that the chemistry vocabularies appear to be too difficult. This due not only to the fact that too many words are used but also to the fact that many are unusual and find no usage outside of works prepared for highly specialized study.

64 Pruitt, Clarence M., "Aim and Content of Chemistry Laboratory Manuals", School Science and Mathematics, 26:507-11, 1927

The investigator attempts to determine the correlation between the aims of chemistry teaching formulated by the Committee or Reorganization of Science in Secondary Schools and the experiments given in fiteen representative laboratory manuals. The conclusions were that as a whole, there is a relatively low degree of correlation between the aim of chemistry teaching and control of laboratory manual.

65 Reed, R. D., Kluckholm, J., Salter, C, and Gies, "Differentiation of Chemistry Course for Variations of Learning Capacities of Pupils", Journal of Chemical Education, 6:327-32, 1929

Tests were given the student groups of one teacher who had given the same instruction as far as possible. For fast classes, the regular test work; for average classes, the regular test work; for slow classes, the regular test work is required.

66 Reed, R. D., "High School Chemistry Demonstration", Journal of Chemical Education, 6:1905-9, 1929.

This article is to report the finding of investigators of the value of lecture demonstration in all science work.

67 Reed, Rufus D., "Preparation of Science Teachers of New Jersey", Journal of Chemical Education, 9:326-44, Feb. 1932.

The questionnaire method is used in this study. It is not desirable to prepare to teach one science only. General science ranks first in number and size of classes, biology is second, chemistry is third, and physics is fourth. The desirable minimum science training fro beginning science teaching should include two years each in biology, physics, and chemistry with a course in giology and in astronomy. More work is desirable in the science field of major interest.

68 Rich, Stephen E.,"Achievements of Pupils in Chemistry", School Science and Mathematics, 25:145-49, 1925.

From the results of examinations made up of many and distinctly different items and given on each of three years just before the close of school to students who had studied chemistry throughout the year, it was concluded in the case

of each test that large proportion of the content of high school chemistry is of little or no value for many who study it. Certainly there are large numbers who effect no mastery of the subject matter. It appears that there are indeed many schools in which nearly none of the students obtain any mastery of the subject matter which is presented to them. The second test shows that such mastery as is obtained is rapidly lost when the student was out of school.

69 Roberts, Ethel L., "A Study of Existing Science Clubs As Portrayed by Current Science Magazine Articles", School Science and Mathematics, 32:948-53, 1932.

This is an analysis of thirty-five separate periodicals showing that information in articles is not adequate to meet demands of new organizers or of present directors. The author lists in order of importance the items that most writers of science club articles deem worthy of mention.

70 Rogers, T. A,, "A Survey of Chemistry Teaching in Wisconsin High Schools", Journal of Chemical Education, 5:1415-24, 1928.

The statement: "Chemistry is one of the most poorly taught subjects in the high school curriculum," challenged the author to conduct a survey of the conditions existing throughout the state to determine whether or not there existed some basis for the above statement. Questionnaires were sent to teachers of the state. The teachers of chemistry along with the teachers of other science subjects have been slow to appreciate the importance of the methods side of presentation.

71 Scofield, Maude B., "An Experiment in Predicting Performance in General Chemistry", Journal of Chemical Education, 4:1168-75, 1927.

The investigator gave tests to ascertain students' abilities necessary for successful attainment in chemistry. The tests measureinclination to pay attention and to follow directions.

72 Scofield, Maude B., "Further Studies on Sectioning in General Chemistry", "Journal of Chemical Education, 7:117-26, Jan. 1930.

This is an investigation to determine the best method of sectioning students in college chemistry. It was brought out that high school grades in mathematics served as a fairly good guide in sectioning both those who had and those who had not had chemistry before. High school physics grades were not as reliable as high school mathematics grades in sectioning. High school chemistry and mathematics grades served as a better basis for sectioning than high school mathematics grades alone. Tests given at the beginning of the quarter are also useful in finding the poor chemistry student.

73 Searle, A. H. and Ruch, G. M., "A Study of Science Articles in Magazines", School Science and Mathematics, 26:3890-96, 1926.

Concerning the amount of scientific information the public pays for in standard magazines, the author found the following: biology sixty-two and two tenths per cent, physics twenty-six and three tenths per cent, chemistry five and one tenth per cent, general science four per cent, and agriculture two and four tenths per cent.

74 Silverman, A., "Intensive Training in Chemistry", Journal of Chemical Education, 5:317-23, 1928.

This is an experimnet to determine whether mixed classes in general chemistry do as well as classes where the students are separated on the basis of preparatory training. The findings indicate that mixed classes do not do as well as segregated classes. Also the experiment proved that intensive instruction yields a higher percentage of superior grades than interrupted training.

75 Spurgin, William, "The Use of the True and False Test in Chemistry Teaching", Journal of Chemical Education, 2:936-38, 1925.

An analysis of the results showed that out of 151 cases where the pupil did not attempt an answer on the short answer test, one hundred were "guessed" right on the true and false test. This bears out the view that a student may not possess a knowledge definite enough to formulate a correct answer himself, but be able to recognize the correct answer or detect the wrong one.

76 Steiner, L. E., "Contributions of High School Chemistry toward Success in College Chemistry Course," Journal of Chemical Education, 9:5300-38, March, 1932.

A study of the chemistry students of Oberlin College was made. Students who have had high school chemistry stand a better chance of making good grades in the first year course than students without such preparation. Students who have had high school chemistry are approximately three times as likely to continue as students who have not. The students in group two

who continue appear to be somewhat more highly selected than those in group one. The great difference in grades made during the first year may be due to: a selective role played by the high school course which tends to attract scientifically inclined students; the preparation given by the course itself.

77 Stevens, Clarence P., "The New Courses in High School Chemistry", School Science and Mathematics, 32:244-50, 1932

This study is an examination of professional literature and
and replies from queries. Results seem to indicate that new chemistry course in high school are not completely college preparatory, but partly so and also adapted to the practical interest of all students.

78 Stewart, A. R., "A Study of Difficulties in Chemistry", School Science and Mathematics, 28:838-48, 1928.

The purpose of this study is to make an analysis of the difficulties of students in general chemistry and to suggest methods of overcoming the difficulties. The difficult topics in chemistry in order of their difficulty are: problems, equations, formulas, word equations, solutions, valence, dissociation, atomic theory, and formulas with valence.

79 Stubbs, M. F., "An Experimental Study of Methods for Recording Laboratory Notes in High School Chemistry", School Science and Mathematics, 26:233-9, 1926.

In view of the various differing opinions and the constant problems which the notebook presents, the writer decided to undertake an experimental investigation in the hope of arriving at some definite conclusions regarding the best method to use for notebook work. The following general conclusions seem

to be justified by the results obtained: the writing of the procedure or method followed does not appreciably aid the memory in retaining the main facts of the experiment. The many extra hours needed by the students to write separate detailed notes and by the instructor to correct them are not justified by the results obtained. If separate notebooks are to be used, they should contain only a brief statement of the object of the experiment and the answers to the questions given in the manual.

80 Thomas, Hopkins L., "A Study of Magazine and Newspaper Science Articles with Relation to Courses in Sciences for High Schools", School Science and Mathematics, 25:7930-80, 1925.

The results of an investigation to see what sceintific information a person needed to know to read intelligently the daily newspapers and a selected list of magazines, it was found that biology is the most common branch of science occuring. Less than one-fourth as much space is given physics and chemistry combined as is given biology.

81 Thompson, F. G. and Rantz, F. A., "The Status of Chemical Education in the High Schools of the State of Washington", School Science and Mathematics, 28:68-73, 1928.

This is a survey attempting to ascertain the enrollment, value of equipment, and teacher preparation in chemistry of the secondary schools of Washington. The findings are: "The high schools of Washington have been classified upon a basis of their enrollment. The money spent for chemistry instruction is an inverse ratio to the size of the school. The preparation of the teachers is in direct ratio to the size of the school."

82 Walker, H., "The High School Chemistry Club", School Science and Mathematics, 28:833-40, 1926

Reports from questionnaires sent 112 schools affirmed

that all are infavor of any properly conducted supervised club. All agree that there is a place for a good club because teachers are pressed for time to do the amount of regular class and laboratory work in the usual course of chemistry.

83 Walters, O., "Industrial Motion Pictures in the Class room", Journal of Chemical Education, 6:1736-46, 1929

Results form the questionnaires indicated that the most interesting pictures were not the ones that students learned from the most. Apparently, high instruction value is sacrificed for high entertainment value. Some pictures appealed to small minority. A majority of students profited by all pictures. Additional films would very often have given additional understanding. Pictures were preferred to laboratory because of less effort required. Pictures are more vivid than visits to plants. They do not involve many technicalities.

84 Worstel, R. A., "Chemical Education In Iowa High Schools", Journal of Chemical Education, 6:1503-11, 1929

The results of the questionnaire study would indicate that there is noting wrong with the training and experience of teachers throughout the state. Subscription to a small chemistry publication will prove helpful in stimulating interest. Chemistry teachers will do well to remember that their value to the community will not be determined by their qualifications alone but rather by how much chemistry they can inpart to those under them.

85 West, Guy A,, "Influence of High School Science on Grades in College Chemistry", School Science and Mathematics, 32:911-3, 1932.

The number of units of high school science a student has taken is of less importance for his success in chemistry at New Mexico State Teachers College than are some other factors, notably intelligence.

86 Westland, E. H., "How to Get a Closer Relationship between the Chemistry of the High School and College", School Science and Mathematics, 26:44-40, 1926.

Questionnaires sent to eight out of twenty universities and colleges revealed concerning the relationship between the chemistry of the high school and college that: colleges are recognizing the work that is being done in high school chemistry. A closer relationship means that thorough methods of presenting the subject to high school students must be developed so that they will have learned to think and know the true meaning of chemistry and its application.

87 Whitton, Emma, "Science in South Carolina High Schools", Journal of Chemical Education, 11:578-479, Oct. 1934.

Information was got from the State Department of Education, reports of county superintendents of education, and of superintendents and teachers of individual schools. The writer is forced to draw the conclusion that South Carolina is far behind in the teaching of science in her high schools, and that one of the most crying needs of the education system of the state is a greater emphasis upon science, scientific equipment, and

especially prepared teachers.

88 Zeismer, Gustave, "Academic and Professional Training of Science Teachers in Wisconsin", School Science and Mathematics, 29:931-42, 1929

Information from questionnaires sent to the teachers of science in Wisconsin indicated that science teachers, in general, do not pursue professional courses to any great extent beyond standard requirements.

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