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Is High School Chemistry a Preparation for College Chemistry

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Martin,
Mansfield
1932

IS HIGH SCHOOL CHEMISTRY A PREPARATION FOR
COLLEGE CHEMISTRY

BY

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A THESIS
SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS

Approved:
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JUNE, 1932.

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PREFACE

I wish to acknowledge my indebtedness to Dr. L. F. Jones for encouragement and criticisms, and to Mr. Bert R. Smith for helpful training. I also want to express my gratitude to Dr. Gordon Wilson for criticising the manuscript. I am likewise grateful to Mr. E. H. Canon, Registrar, for making it possible for me to obtain information from institutional records in his office.

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CHAPTER 1

INTRODUCTION

The subject of this study grew out of a desire to estimate the value of high school chemistry and its relation to college chemistry. The purpose is to bring about a better understanding of the necessity of a closer tie-up between different levels of our educational system. Life and growth are continuous processes, and, if education is life, we must make it a continuous experience. While limited because of incomplete records and changing classifications of our high schools, it is hoped that this study will lead to a further and more scientific study of related problems in this field.

Until 1914 when the world burst into flame in one great war, chemistry was a science for the few. But just as Napoleon, more than a century before, had called upon the French scientists for aid, so in the beginning of the Great War each nation mobilized its chemists. The demand for munition, foods, medicines, and chemicals involved as never before the application of practical chemistry.

With the blockade of Germany came the need of home production of dyes, medicines, and pure chemicals. Then, as we plunged into the war, we were forced to develop explosives and chemical warfare weapons.

As a result of the need of applying science to the world's

work, the war organized in the nation a great propaganda for the diffusion of scientific knowledge and for education of the public in science. This brought on an increasing demand for educated men and women, and as a result college enrollments were doubled and trebled. Many were entering college who had not dreamed before of the possibility of such training.

Thus the type of students taking chemistry has changed since 1914. Before the war only the persons expecting to make a life's work of it entered the chemistry classes. The factors, then, that must be considered as affecting the teaching of chemistry from 1914 on, and which raise a multitude of new questions, can be briefly formulated as follows:

- "(1) The growth in student body, which has not only taxed the facilities of our higher institutions of learning, but has brought in a mass of student raw material, the value of which is questionable;
- (2) An enormous increase in achievement in pure and applied chemistry.
- (3) The recognition of the need of accurate and continued research as a basis for industry, for the utilization of waste products, and for future welfare, both local and national;
- (4) An increasing public appreciation of, and knowledge regarding the value of scholarly and scientific training."¹ Scholarship

With the increasing of college enrollment the training of the teachers of the secondary school became better, and the instruction in high school has become much better.²

¹ F. B. Dains, "Advance in the Teaching of Chemistry," Journal of Chemistry Education (April, 1932), p. 745.

² Ibid., p. 748.

Chemistry came down to the secondary school instead of building up from it. Therefore it brought its college objectives and methods with it to a large extent. With the increasing number taking chemistry a definite effort must be made by teachers of chemistry to recognize more clearly than ever before the various objectives of the present-day student.

The history of chemical education would lead to the following conclusions:

1. The main part of the instruction has been designed for the pupil expecting to make chemistry a life's study or work.
2. On the other hand there is a growing sentiment that everybody needs to know something about chemistry and its relationships to man's well-being. It would seem that all would argue that this is needed, but how and in what year or years it can be best accomplished is a question. Should the secondary school give an appreciation and the college the technical training? As yet we are not able to measure appreciations; so who knows whether or not either teaches appreciation?

Without any quantitative method of evaluating achievement, but as a matter of opinion, the idea grew up among educators that chemical instruction must begin with individual laboratory work as an essential element. Many secondary

schools have been unable to provide facilities for individual work in chemistry as well as for other sciences. This fact in connection with our rules of accrediting schools has been increasingly a source of embarrassment. With the present tendency to appraise our educational practices in a scientific way, we are beginning to realize that we have adopted a costly method with a background of opinion only. Perhaps the system is valuable for capable students who know they want to become chemists. But it is being questioned on many sides as a method for masses of students finding their way to the last years of high school and the first years of college. In fact Indiana University found a system of lecture-demonstration satisfactory.¹ The investment of teachers' and students' time should be such as to insure the greatest returns.

In accounting for money spent in value received the question naturally arises, "Is high school chemistry a preparation for college chemistry?" It is not to be construed that the answer to this question will determine the value of high school chemistry. Education is life and not necessarily a preparation for future life. Therefore, if it helps a student while in high school or in a way that does not prepare him for college chemistry, it may have its value.

¹ V. F. Payne, "Lecture Demonstration and Individual Method Compared." Journal of Chemical Education (May 1, 1932), p. 932.

Whether or not it is a preparation has been a subject of discussion and opinion for quite a while. Some scientific studies have been made, but the question is still alive.

The Committee of Chemical Education of the American Chemical Society reported:

"The Committee does not feel that it is practical or necessary to have two different courses in High School Chemistry, that is,-- one course for those who expect to attend College and one for those who do not." ¹

This committee prepared a syllabus for high school chemistry and one for first year College to prevent overlapping and duplication of effort. During the construction of the syllabi much of the high school material was transferred to the college curriculum. ²

¹ "Correlation of High School and College Chemistry." Journal of Chemical Education (May, 1927), p. 641.

² Ibid., p. 640.

Mr. Glen Wakham, teacher of college chemistry in the University of Colorado, has made a study of his classes in beginning chemistry for the last eight years. ^{STOP) NEXT DAY} Below is a table of his findings:¹

TABLE I

GRADE AVERAGES FOR EIGHT YEARS IN COLLEGE CHEMISTRY

With			Without		
High School Chemistry			High School Chemistry		
Years	Number	Average	Number	Average	
1923-24:	251	: 77.6	: 185	: 76.8	
1924-25:	218	: 77.3	: 192	: 77.5	
1925-26:	228	: 77.9	: 178	: 76.8	
1926-27:	231	: 77.7	: 181	: 77.2	
1927-28:	212	: 78.3	: 176	: 77.3	
1928-29:	208	: 78.5	: 183	: 78.1	
1929-30:	212	: 81.4	: 176	: 80.3	

He came to the conclusion that having had high school chemistry made very little difference, as there was only one per cent difference in averages in college chemistry. In the University of Colorado students that have had high school chemistry and those who have not take beginning chemistry to-

¹Glen Wakham, School & Society (Aug. 9, 1930), pp. 20, 708.

gether. In the last two years two sections have been created, and those having high school chemistry are in a separate group. If high school chemistry is a preparation for college chemistry, this preparation was needed.

We must never lose sight in our teaching of the fact that chemistry is an experimental science, and that the only general test of truth is the careful interpretation of accurate experimental data.

CHAPTER II

SET-UP OF STUDY

This study is based upon the records of students who had had beginning chemistry in the Western Kentucky Teachers College. Records in the registrar's office were investigated. Individual cards were made out for each student showing grade in college chemistry, high school graduated from, whether they had high school chemistry, and rating of high school the year of graduation. Three files were used in gathering this data: General File from 1923 until February, 1932, Life Certificate File, and File of Graduates.

The general files furnished data for comparing students who had not finished the Life Certificate course or taken a degree. The records of seven hundred and thirty of those who had college chemistry were complete enough for use in this comparison. The students who had high school chemistry were compared with those who had not had high school chemistry. Comparison was based on per cent of A's, B's, C's, D's, F's; also mean, Q_1 and Q_3 . This group was made up of 205 students with high school chemistry, and 525 without high school chemistry.

The Life Certificate File showed seventy-five students with high school chemistry as having had college chemistry. These two groups were compared in per cent of A's, B's, C's, D's, F's, and mean, Q_1 , Q_3 .

Records of graduates were likewise charted, and grades of students with and without high school chemistry were compared in per cent of A's, B's, C's, D's, F's, and mean, Q_1 and Q_3 .

Point averages in all college work of graduates were used in noting the effect on students of different levels of having or of failure to have had high school chemistry.

The grades were assigned values as follows:

A-90 to 99

B-80 to 89

C-70 to 79

D-60 to 69

F-50 to 59

Of the 300 students in this group on point average 10 ranked A, 114 B, and 176 C.

A composite study of the three groups was made. The college chemistry grades of those students who had high school chemistry were compared as to mean, Q_1 , Q_3 , and per cent making A's, B's, C's, D's, and F's with those students who had not had high school chemistry.

To further study the effect of high school chemistry on grades made in college chemistry, students were classified according to the rating of the high school from which they graduated. This included 443 cases representing 192 high schools. Rating was found in State Annual High School Registers for the years 1920-21 to the school year of 1930-31. Two hundred

forty-four were classified as graduates of Southern Association High Schools.

Schools ranking A until 1925, and then joining the Southern Association are classified as Southern Association Schools. One hundred forty-three others were classified as graduates from A high schools. One hundred eighty-one were classified as graduates from B class high schools, and eighteen were graduates of unaccredited high schools.

Mean, Q_1 , Q_3 , and per cent of A's, B's, C's, D's, and F's were compared.

CHAPTER III

ANALYSIS AND EVALUATION OF DATA

In tabulating data some of the tables are based upon such few cases that only tendencies and questions for future study are shown. While as a large number of cases are represented as could be obtained from records used, it must be remembered that this study only reflects the conditions in that part of Kentucky served by the Western Kentucky Teachers College. The conditions may not be the same in different sections of the country.

In Tables VI and VII the number of cases was greatly reduced because in many instances the year of high school graduation was not recorded; and if high school had changed in rating, the case had to be discarded.

An unprejudiced analysis has been the aim of this study. Records copied from the registrar's office will be filed with the Education Department of the Western Kentucky State Teachers College for use in further study of this problem.

TABLE II

A COMPARISON OF COLLEGE CHEMISTRY GRADES OF STUDENTS
WITH AND WITHOUT HIGH SCHOOL CHEMISTRY.*

With High School Chemistry			Without High School Chemistry		
College Grades	No.	Per cent	No.	Per cent	
A	28	13.7	37	7.	
B	41	20.	83	15.8	
C	61	29.7	173	32.9	
D	39	19.	93	17.7	
F	36	17.5	139	26.5	
Total	205		525		
Q ₁		63.9		59.4	
Mean		76.		70.9	
Q ₃		84.3		79.9	

*Records from General File Registrar's Office.

This table shows that people who have had high school chemistry make on an average 5 per cent more in beginning college chemistry. About the same variation also appears at the first and third quartile. Those having had high school chemistry make a larger per cent of A's and a smaller per cent of F's.

TABLE III

A COMPARISON OF COLLEGE CHEMISTRY GRADES OF LIFE CERTIFICATE GRADUATES WITH AND WITHOUT HIGH SCHOOL CHEMISTRY*

With High School Chemistry			:	Without High School Chemistry		
College Grades	No.	Per cent	:	No.	Per cent	:
A	17	22.7	:	31	10.9	:
B	29	38.7	:	71	25.	:
C	21	28.	:	121	42.6	:
D	7	9.3	:	50	17.6	:
F	1	1.3	:	11	3.9	:
Total	75		:	284		:
Q ₁		72.7	:		70.8	:
Mean		82.2	:		77.1	:
Q ₃		84.2	:		84.	:

*Records from Registrar's Office.

Likewise in the Life Certificate files those having had high school chemistry made better grades in college chemistry, ranging from 2 per cent in the first quartile to less than 1 per cent difference in the third quartile, and the mean being 5 per cent higher for those who have had high school chemistry. A much higher per cent of those who had had high school chemistry made A or B in college chemistry and a much lower per cent made F or D.

TABLE IV

A COMPARISON OF COLLEGE CHEMISTRY GRADES OF DEGREE STUDENTS WITH AND WITHOUT HIGH SCHOOL CHEMISTRY.*

With High School Chemistry			:	Without High School Chemistry		
College	No.	Per cent	:	No.	Per cent	
Grade	:	:	:	:	:	
A	20	25.9	:	48	21.4	
B	28	36.4	:	74	33.	
C	24	31.2	:	70	31.3	
D	3	3.9	:	25	11.2	
F	2	2.6	:	7	3.1	
Total	77		:	244		
Q ₁		75.9	:		68.4	
Mean		83.3	:		80.8	
Q ₃		90.4	:		88.9	

*Records from Registrar's Office.

Students who have finished the A. B. or B. S. degree also seem to have been better prepared for college beginning chemistry, if they had had high school chemistry. It seems to make more difference in students in the lower quartile than in the upper quartile, the difference ranging from a fraction over 1 per cent for the third quartile to 7 per cent for the first quartile.

TABLE V

A COMPARISON OF COLLEGE CHEMISTRY GRADES OF STUDENTS
WITH AND WITHOUT HIGH SCHOOL CHEMISTRY.*

With High School Chemistry 357			:	Without High School Chemistry 1033		
College	No.	Per cent	:	No.	Per cent	
Grades	:	:	:	:	:	
A	65	18.2	:	116	11.3	
B	98	27.4	:	228	22.1	
C	106	29.7	:	364	35.2	
D	49	13.7	:	168	16.3	
F	39	10.9	:	157	15.2	
Total	357		:	1033		
Q ₁		70.1	:		66.	
Mean		77.8	:		74.8	
Q ₃		87.5	:		83.8	

*Composite of Tables II, III, and IV.

This composite shows that the mean for those having had high school chemistry is 3 per cent higher than for those who have not had high school chemistry; also a higher per cent making A's and B's in college chemistry from the group having had high school chemistry and a smaller per cent failing or making D's in the group who have had high school chemistry. As this table covers 1390 cases, it seems rather logi-

cal to conclude that high school chemistry is of some advantage to students taking college chemistry. However, it is not as much assistance as might be expected, but if it improves the average grade 3 per cent, it must be beneficial.

TABLE VI

A COMPARISON OF COLLEGE CHEMISTRY GRADES MADE BY GRADUATES OF VARIOUS RATED HIGH SCHOOLS OF KENTUCKY WITH AND WITHOUT HIGH SCHOOL CHEMISTRY.*

With				Without				
High School Chemistry				High School Chemistry				
<u>Southern Association</u>								
College	:	:	:	:	:	:	:	
Chemistry	:	No.	:	Per cent:	No.	:	Per cent	
Grades	:	:	:	:	:	:	:	
A	:	19	:	14.8	:	9	:	7.7
B	:	32	:	25.	:	21	:	18.1
C	:	34	:	26.7	:	34	:	29.3
D	:	26	:	20.3	:	18	:	15.5
F	:	17	:	13.2	:	34	:	29.3
Total	:	128	:		:	116	:	
	:	:	:	:	:	:	:	:
Q ₁	:		:	65.8	:		:	58.3
Mean	:		:	75.8	:		:	70.9
Q ₃	:		:	85.9	:		:	80.5

TABLE VI (continued)

A Class High Schools

With			:	Without		
High School Chemistry			:	High School Chemistry		
			:			
College	:	:	:	:	:	:
Chemistry	No.	Per cent	:	No.	Per cent	:
Grades	:	:	:	:	:	:
A	3	7.9	:	10	9.5	:
B	6	15.8	:	19	18.1	:
C	11	28.9	:	28	26.7	:
D	6	15.8	:	19	18.1	:
F	12	31.6	:	29	27.6	:
Total	38		:	105		:
Q_1		57.9	:		59.1	:
Mean		70.2	:		71.4	:
Q_3		79.6	:		81.4	:

TABLE VI (continued)

B Class High Schools

With High School Chemistry			:	Without High School Chemistry		
College	No.	Per cent	:	No.	Per cent	
Chemistry			:			
Grades			:			
A	1	5.5	:	7	4.3	
B	2	11.1	:	20	12.3	
C	8	44.4	:	58	35.6	
D	4	22.2	:	32	19.6	
F	3	16.7	:	46	28.2	
Total	18		:	163		
Q ₁		63.7	:		58.9	
Mean		78.8	:		69.1	
Q ₃		78.1	:		77.6	

TABLE VI(continued)

Unaccredited High Schools

With High School Chemistry			:	Without High School Chemistry		
			:			
College	:	:	:	:	:	:
Chemistry	No.	Per cent	:	No.	Per cent	:
Grades	:	:	:	:	:	:
A	:	:	:	2	11.1	:
B	:	:	:	4	22.2	:
C	:	:	:	7	39.	:
D	:	:	:	2	11.1	:
F	:	:	:	3	16.7	:
Total	0	:	:	18	:	:
Q ₁	:	:	:	:	67.5	:
Mean	:	:	:	:	75.	:
Q ₃	:	:	:	:	83.8	:

*Records of Registrar's Office and Kentucky School Directories.

In the interpretation of this table bear in mind that S. A. or Southern Association high schools are rated as A high schools but were separated to allow a comparison between them and other A schools. As stated in Chapter II, A high schools from 1921 to 1925, and then joining the Southern Association, are considered in the Southern Association for the entire time.

Those having had high school chemistry made better grades in college chemistry from all different rated high schools except the A class high schools, and because only 38 cases had had high school chemistry, we can not draw any conclusions from the fact that students without high school chemistry made about 1 per cent more in college chemistry on the average.

None of the students from unaccredited high schools had high school chemistry.

TABLE VII

A COMPARISON OF COLLEGE CHEMISTRY GRADES MADE BY GRADUATES OF HIGH SCHOOLS OF DIFFERENT RATING IN THE STATE.*

College: Grades :	Rating of High Schools							
	: S. A.		: A		: B		: Unaccredited	
	: High Schools		: High Schools		: High Schools		: High Schools	
	: No.:	Per cent:	: No.:	Per cent:	: No.:	Per cent:	: No.:	Per cent:
A	: 28 :	14.5	: 13 :	9.1	: 8 :	4.4	: 2 :	11.1
B	: 53 :	21.3	: 25 :	17.5	: 22 :	12.2	: 4 :	22.2
C	: 68 :	27.9	: 39 :	27.3	: 66 :	36.5	: 7 :	39.
D	: 44 :	18.	: 25 :	17.5	: 36 :	19.9	: 2 :	11.1
F	: 51 :	20.9	: 41 :	28.6	: 49 :	27.	: 3 :	16.7
Total	: 244 :		: 143 :		: 181 :		: 18 :	
Q ₃	:	83.8	:	80.5	:	77.7	:	83.7
Mean	:	73.5	:	71.	:	71.2	:	75.
Q ₁	:	62.3	:	58.7	:	59.2	:	67.5

*Registrar's Office and Kentucky School Directories.

The students of Southern Association High Schools make better grades in college chemistry than any student except those from unaccredited schools. Likewise students of A high schools make slightly better grades than graduates of B schools.

Because of the small number of students from the unaccredited schools no conclusive statement can be made. The fact that these students made better grades in college chemistry might be due to a more select group of students entering college from communities with unaccredited high schools.

TABLE VIII

POINT AVERAGES AND COLLEGE CHEMISTRY GRADES OF STUDENTS
WITH AND WITHOUT HIGH SCHOOL CHEMISTRY.*

Students with Point Averages of A

With High School Chemistry			:	Without High School Chemistry		
Grades in:	No.:	Per cent	:	No.	:	Per cent
College :	:	:	:	:	:	:
Chemistry:	:	:	:	:	:	:
A	3	75	:	5	:	83.3
B	1	25	:	1	:	16.6
C	0	0	:	0	:	0.
D	0	0	:	0	:	0.
F	0	0	:	0	:	0.
Total	4		:	6	:	
Q ₁		85.	:		:	95.
Mean		92.5	:		:	93.5
Q ₃		96.	:		:	97.

TABLE VIII(continued)

Students With Point Averages of B

With			:	Without		
High School Chemistry			:	High School Chemistry		
			:			
Grades in	No.	Per cent	:	No.	Per cent	
College	:	:	:	:	:	
Chemistry	:	:	:	:	:	
A	15	51.7	:	37	43.5	
B	11	37.6	:	31	36.4	
C	1	6.7	:	15	17.6	
D	2	13.3	:	1	1.1	
F	0	0	:	1	1.1	
Total	29		:	85		
Q ₁		83.4	:		81.4	
Mean		88.4	:		87.	
Q ₃		94.2	:		94.3	

* Records from Registrar's Office.

TABLE VIII(continued)

Students With Point Averages of C

With High School Chemistry			:	Without High School Chemistry		
Grades in	No.	Per cent	:	No.	Per cent	
College	:	:	:	:	:	
Chemistry	:	:	:	:	:	
A	2	4.5	:	6	4.5	
B	16	36.3	:	42	31.8	
C	22	50.	:	54	40.9	
D	2	4.5	:	24	18.1	
F	2	4.5	:	6	4.5	
Total	44		:	132		
Q ₃		84.4	:		83.6	
Mean		78.2	:		76.4	
Q ₁		73.2	:		70.5	

Because of the few students making a point average of A, no comparison can be made of the A group.

In the B group those who have had high school chemistry made about 1 per cent more than those who have not had high school chemistry.

Likewise the C group students having had high school chemistry made slightly better grades. No special significance can be attached to the Q₁, Q₃, as they have about the

same variation as the mean.

From the above data it seems that having had high school chemistry improves the college chemistry grades of C students more than it does for A or B students. This is also shown by the fact that general file students were also helped more by high school chemistry.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The study of chemistry is as old as history, but as a branch of study for the public high school it is relatively new. The World War brought a demand for a general knowledge of science in everyday life. Formerly any one desiring to turn to chemistry work for a living studied chemistry; now it is taught as a regular part of our secondary school work.

Quite a number of studies have been made on the best method or methods of teaching chemistry. Most of them evolve themselves into laboratory versus teacher-demonstration. This study does not deal with technique, devices or methods in the teaching of chemistry, but it attempts to establish value of high school chemistry as a preparation for college chemistry.

Students who have had high school chemistry are slightly better prepared for college chemistry than are those who have not had such course. This study shows about 3 per cent difference in averages in favor of those having high school chemistry.

Graduates of high schools belonging to the Southern Association of Secondary Schools, showed a very slight increase in average made over A and B high schools. There was practically no difference in the grades of graduates from A and B high schools.

Only eighteen cases were represented in the unaccredited high schools. The grades averaged better than grades of S. A. A or B high schools, but because of the small number of cases this fact is not significant.

Conclusions

This study shows that high school chemistry is a slight preparation for college chemistry. The analysis shows that students in the lower quartile are helped more by having had high school chemistry than those in the upper quartile, likewise, students with a low point average were helped more by high school chemistry than those with high point averages.

The Southern Association high school graduates made better grades in college chemistry than do graduates of other A or B high schools. The fact that unaccredited high school graduates' averages were highest can not be given much weight, as only eighteen cases were represented. A more select group going on to college from unaccredited high schools might account for this fact.

For some reason high school chemistry is not functioning as might be expected. This may be due to the fact that it is not taught in such a way as to prepare students for college chemistry, or high school and college chemistry may not be properly integrated.

Recommendations

1. Definite standards should be set up for high school chemistry, and these should be recognized and demanded by the colleges. The college beginning chemistry course should be integrated with high school chemistry. Colleges and high schools should cooperate in integrating their courses in chemistry.
2. A study in which the limitations of this study are removed should be made. A standardized test should be given at the start of college chemistry and one at the close of the term. In this way the preparation from the high school course would be shown and the results of college chemistry measured.
3. A complete study of records of graduates from all classes of high schools should be made to determine which one gives the best foundation for college work and ways of improving others.
4. In view of the fact that there is only a 3 per cent higher average grade made by students who have had high school chemistry over those who have not had high school chemistry, grouping according to ability of pupils might improve the results of college chemistry more than grouping according to high school preparation. The two types of grouping should be tried out.
5. A study of the preparation of teachers teaching high school in the state should be made in order to throw some light on what is needed in high school chemistry.

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