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THE EFFECT OF TRAINING IN HIGH
SCHOOL CHEMISTRY ON ACCOMPLISHMENT
OF FIRST TERM CHEMISTRY
AT MICHIGAN STATE COLLEGE
THESIS FOR THE DEGREE OF M. A.
Tac P. Gies
1931

THESIS

Chemistry - Study &
teaching

Tulle High school Chemistry

The Effect of Training in High School Chemistry on
Accomplishment of First Term Chemistry at
Michigan State College

A Thesis Presented for the
Degree of Master of Arts

By
Tac P. Gies

MICHIGAN STATE COLLEGE

1931

THESIS

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THE EFFECT OF TRAINING IN HIGH SCHOOL CHEMISTRY ON
ACCOMPLISHMENT OF FIRST TERM CHEMISTRY AT
MICHIGAN STATE COLLEGE

INTRODUCTION

Purposes of the Study

In view of the fact that 73.2 percent (1) of the students who enroll for first term chemistry at Michigan State College have had a year's work in chemistry at high school, the Department of Chemistry at Michigan State College has differentiated the course of study for first term chemistry students. Students who have chemistry in high school are given a different course of study (2) than students who have no training in chemistry in high school.

The purposes of this study are: 1. To determine statistically whether or not training in high school chemistry has any effect on accomplishment of first term chemistry students at Michigan State College. 2. To determine whether or not the plan of separating first term chemistry students into two groups, those having had high school chemistry and those who have not had high school chemistry, is of any significant value. 3. To determine the trend of accomplishment made during a decade (1920-1929) of the first term chemistry students at Michigan State College.

(1)

Percentage figured over a ten-year period (1920-1929).

(2) See page 5 for an outline of course of study.

History of Problem

In a paper relevant to this study, Dr. Glen Wakeham of the University of Colorado states, "A previous high school course in chemistry is shown to have little, if any, effect upon the success of a college chemistry student." (3) Dr. Wakeham studied the situation in chemistry at the University of Colorado for eight years and has pointed out that in the University of Colorado, when the study of chemistry is continued, there is very little difference between the grades of college students who have had high school chemistry and those who have not had high school chemistry.

The grades considered in the above report were freshman grades of the first term only. (4) The results of the research at Michigan State College were based on first term only and show a significant difference between the grades of the first term chemistry students who have had high school chemistry and those who did not have high school chemistry. The difference between the results of this paper and the results obtained at the College of Colorado might be due to any of a large number of causes, such as:- difference in aims of the courses of study in chemistry in the high school from which the students come; differences in the aims of the college chemistry courses;

(3) Glen Wakeham, School and Society, XXXII (August 9th., 1930, pp. 206-208
(4) See tables in appendix p. 22

methods of teaching in both the high schools and the college; difference in the personnel of the high school teachers, and other causes.

Source of Material Used

The data were collected from the permanent record files of the Department of Chemistry of Michigan State College. Every student who has taken chemistry at Michigan State College has a permanent record card on file. These cards were consulted and the following information recorded from the cards covering the years 1920-1929 inclusive; (a) date, (b) grade of each student for the first term. The data were then classified and condensed to the form shown in the appendix (see page 24). The total number of grades used in the computations was 6,817. It would seem that this number of grades is large enough to be representative.

The Effect of Training in High School Chemistry on
Accomplishment of First Term Chemistry at
Michigan State College

Part I

Through the courtesy of the Department of Chemistry of the Michigan State College the permanent record files and the yearly record ledgers were made available for this study.

The permanent record files contain some 18,000 personal record cards arranged alphabetically. There is a permanent record card for each student that takes a course in chemistry, who had taken first term chemistry during the years 1920-1929 inclusive.

- a. Whether or not the student had taken two semesters of chemistry in high school.
- b. The student's grade for first term chemistry, the course number being 1 for the years 1920 to 1924 inclusive, and 101 for the years 1927 to 1929 inclusive.

This information was then classified and totaled in the different groups as follows:

- a. Students who had taken first term chemistry at M.S.C. at some time during the years 1920 to 1924 inclusive and who had taken two semesters of chemistry in high school.
- b. Students who had taken first term chemistry at M.S.C. at some time during the years 1920 to 1924 inclusive and did not have two semesters of chemistry in high school.
- c. Students who had taken first term chemistry at some time during the years 1925 to 1929 inclusive and had two semesters of chemistry in high school.

- d. Students who had taken first term chemistry at some time during the years 1925 to 1929 inclusive and did not have two semesters of chemistry in high school.

The following cases were not recorded and do not enter into the computations:

- a. Students having had more than two semesters of chemistry in high school.
- b. Students having had the short course in agricultural chemistry.
- c. Students receiving an "incomplete" grade in chemistry.

An "incomplete" is, ".....given only when a student is prevented by illness or other fortuitous circumstances from completing his work." (1)

The grades for the fall term courses 101 and 101a in 1930 (2) were recorded from the permanent record ledgers.

For students not having had high school chemistry, the plan used for first term chemistry course 101 at Michigan State College consists of:

- a. lectures-three, fifty minute periods per week
- b. quizzes-two, fifty minute periods per week
- c. laboratory-two, fifty-five minute periods per week

For students having had high school chemistry, the plan used for first term chemistry course 101a at Michigan State College consists of:

- a. lectures- two, fifty minute periods per week
- b. quizzes- one, fifty minute period per week
- c. laboratory- two, fifty-five minute periods per week

The same subject matter is covered in both courses 101 and 101a.

(1) Michigan State College Catalog Number 1929-1930 p.24

(2) See appendix, Table XIII and Table XIV for summary of data.



PART II

DETERMINATION OF DIFFERENCES IN GRADES OF STUDENTS
IN FIRST TERM CHEMISTRY AT MICHIGAN STATE
COLLEGE DUE TO TRAINING IN HIGH
SCHOOL CHEMISTRY1. Differences Based on Percentages

Table I, page 7, shows the percentages of students who had two semesters of high school chemistry and continued the study of chemistry at Michigan State College. The distribution approaches a normal distribution.⁽¹⁾ Table II, page 7, shows the same information for the students who did not have high school chemistry, and who took the same course as the students who had high school chemistry. In this table the percentages of students' grades approach a normal distribution only as far as the satisfactory grades (A, B and C) are concerned. The number of failures for students who did not have high school chemistry was much larger than would be indicated by a normal distribution.

The mean grade of the students who have had high school chemistry is 79.71 and the mean grade of the students who did not have high school chemistry is 72.20. This difference of 7.51 is significant of the assumption that two semesters of

(1) See appendix, Fig. 2 for Frequency Polygon of the distribution.

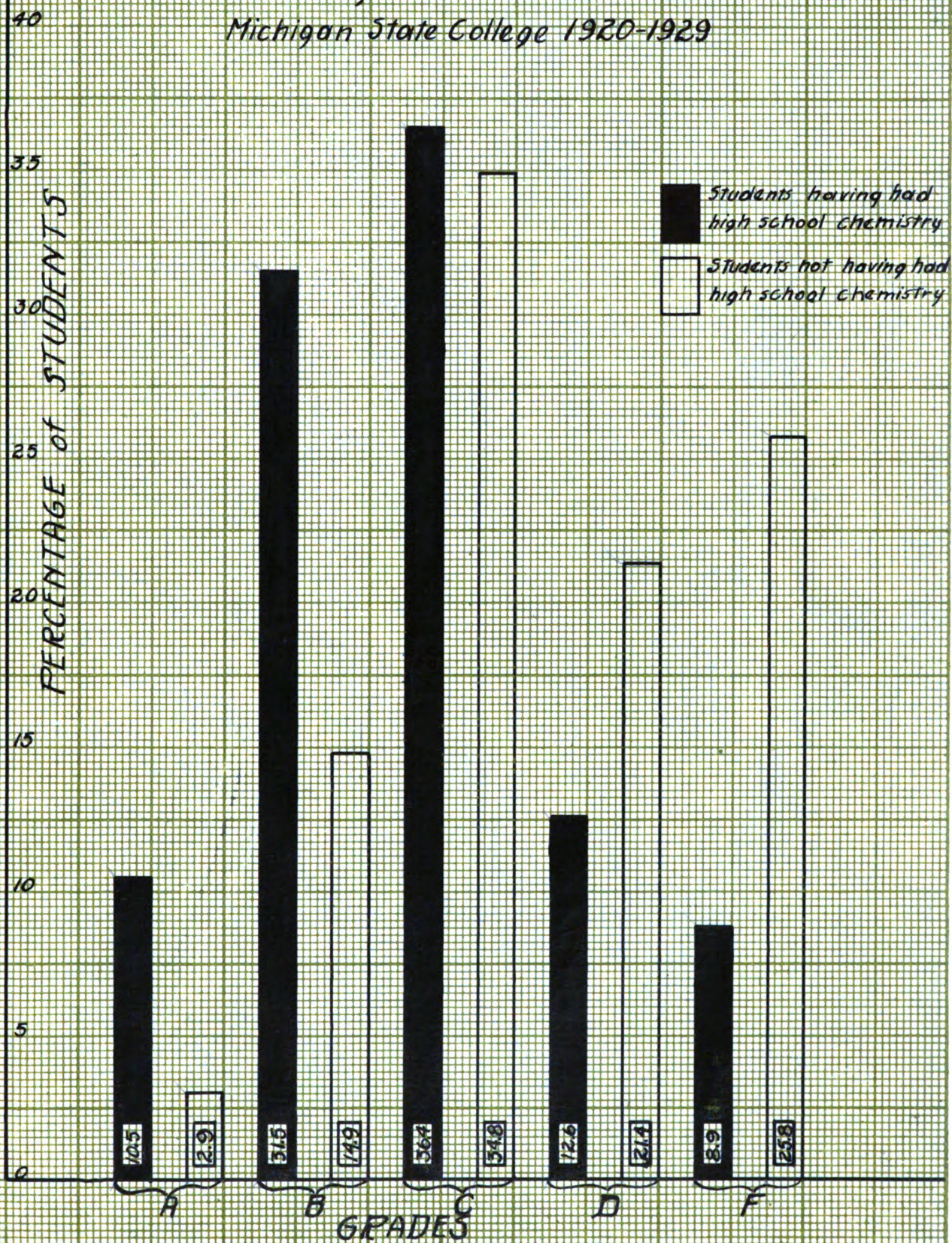
TABLE I. THE DISTRIBUTION OF GRADES OF FIRST TERM
CHEMISTRY STUDENTS AT MICHIGAN STATE COLLEGE
DURING THE YEARS 1920-1929 INCLUSIVE,
WHO HAVE HAD HIGH SCHOOL CHEMISTRY

Grades and their numerical value	Number of students	Percent of students
A 95 to 100	462	10.54
B 85 to 94.9	1381	31.51
C 75 to 84.9	1595	36.39
D 65 to 74.9	552	12.59
F Below 64.9	393	8.97
Total	4383	100.00

TABLE II. THE DISTRIBUTION OF GRADES OF FIRST TERM
CHEMISTRY STUDENTS AT MICHIGAN STATE COLLEGE
DURING THE YEARS 1920-1929 INCLUSIVE,
WHO HAVE NOT HAD HIGH SCHOOL CHEMISTRY

Grades and their numerical value	Number of students	Percent of students
A 95 to 100	49	2.98
B 85 to 94.9	246	14.94
C 75 to 84.9	574	34.87
D 65 to 74.9	352	21.39
F Below 64.9	425	25.82
Total	1646	100.00

Fig. 1-Distribution of First Term
Chemistry Grades of Students at
Michigan State College 1920-1929



chemistry in high school is an aid for higher grades in first term chemistry at Michigan State College. On page 23 of the appendix is a frequency polygon of the two distributions. This graph shows again that the number of failures is relatively high for the students who did not have high school chemistry, and the number of exceptionally good grades is relatively low.

2. Differences Based on the Number of Points Made

As a means of comparing the two groups in another manner, the point system was used. The point system as explained in the Michigan State College catalog is as follows:

"Three points are allowed for each credit of work of A grade; two points for each credit of B grade; one point for each credit of C grade. No points are allowed for work of D grade or lower. Grades of X or F will be given one negative point for each credit." (2)

The approximate numerical values given the letter grades is given below:

A = 95 to 100
 B = 85 to 94.9
 C = 75 to 84.9
 D = 65 to 74.9
 F = Below 64.9

Tables III and IV, page 10, show the distribution by points made by the different groups over a period of two, ten year periods.

(2) Michigan State College Catalog Number 1929-1930, p.24

TABLE III. DISTRIBUTION BY POINTS MADE BY THE STUDENTS
IN FIRST TERM CHEMISTRY AT MICHIGAN STATE COLLEGE
WHO HAVE HAD HIGH SCHOOL CHEMISTRY DURING
THE YEARS 1920-1929 INCLUSIVE

Grade	Number of points	Number of students	Aggregate number of points	A and B only	A, B and C
A	3	462	1386	1386	1386
B	2	1381	2762	2762	2762
C	1	1595	1595		1595
D	0	552			
F	-1	393	-393		
Totals		4383	5350	4148	5743
Average no. of points			1.22	2.25	1.67

TABLE IV. DISTRIBUTION BY POINTS MADE BY THE STUDENTS
IN FIRST TERM CHEMISTRY AT MICHIGAN STATE COLLEGE
WHO HAVE NOT HAD HIGH SCHOOL CHEMISTRY DURING
THE YEARS 1920-1929 INCLUSIVE

Grade	Number of points	Number of students	Aggregate number of points	A and B only	A, B and C
A	3	47	147	147	147
B	2	246	492	492	492
C	1	574	574		574
D	0	352			
F	-1	425	-425		
Totals		1646	788	639	1213
Average number of points			.4787	2.16	1.395

The most outstanding difference in the average number of points made was found when all grades were considered. The average number of points made by the students who have not had high school chemistry is .478 while the average number of points made by the students who have had high school chemistry is 1.22 or more than 2.5 times as many as those who did not have high school chemistry.

The average number of points for the superior grades (A and B), do not vary greatly nor do the average number of points for the good grades, (A, B and C) but in each and every case the average number of points of the students who have had high school chemistry is greater than the average number of points of the students that did not have high school chemistry.

From the above facts it would seem that some measures should be taken to overcome the 47.21 percent of unsatisfactory grades in first term chemistry of students who had no chemistry training in high school. The Department of Chemistry of Michigan State College initiated a course of study, in the fall term of 1930, to fit the needs of such students. The course number is 101a and is outlined on page 5.

A discussion of the success of the course 101a follows in Part III.

PART III

THE RESULTS OF GIVING A DIFFERENTIATED COURSE OF STUDY IN
CHEMISTRY AT MICHIGAN STATE COLLEGE TO STUDENTS WHO
HAD NO CHEMISTRY IN HIGH SCHOOL1. Comparison of Percentages of Students' Grades in
Course 101 and 101a during the Fall Term of 1930

In tables V and VI, page 13, are computed for comparison and contrast, the percentages of students taking chemistry courses 101 and 101a.

Course 101a is the course offered for students having had two semesters of high school chemistry. Course 101 is the course offered to students who did not have two semesters of chemistry in high school.

A greater percentage of students in course 101a received higher grades than the students in course 101 but the difference between them is slight when compared with the percentages of students of both groups before they were separated.

2. Comparison of Differences in Percentages of Grades
before the Two Groups were Separated and a Comparison of
Differences in Percentages of Grades after the Two Groups
were separated

Tables VII and VIII, page 14, show the distribution of differences in percentages of the two groups of students' grades, during the years 1920 to 1929 inclusive and also for the fall term of 1930.

The differences between the two groups during 1920 to

TABLE V. DISTRIBUTION OF GRADES OF FIRST TERM CHEMISTRY STUDENTS WHO HAD THE DIFFERENTIATED CHEMISTRY COURSE 101a AT M.S.C. DURING THE FALL TERM 1930, WHO HAD HIGH SCHOOL CHEMISTRY

Grade	Number of students	Percent of students
A	82	13.5
B	205	33.8
C	193	31.9
D	81	13.4
F	45	7.4
Totals	606	100.0

TABLE VI. DISTRIBUTION OF GRADES OF FIRST TERM CHEMISTRY STUDENTS WHO HAD THE DIFFERENTIATED CHEMISTRY COURSE 101 AT M.S.C. DURING THE FALL TERM 1930, WHO DID NOT HAVE HIGH SCHOOL CHEMISTRY

Grade	Number of students	Percent of students
A	16	8.8
B	54	29.6
C	64	35.1
D	26	14.4
F	22	12.1
Totals	182	100.0

TABLE VII. THE DISTRIBUTIONS OF DIFFERENCES IN PERCENTAGES BETWEEN THE GRADES OF STUDENTS HAVING HAD HIGH SCHOOL CHEMISTRY AND THOSE WHO HAVE NOT HAD HIGH SCHOOL CHEMISTRY DURING THE YEARS 1920-1929.

Grades	Percent of Students with H. S. Chem.	Percent of Students without H.S. Chem.	Difference of percents
A	10.54	2.98	7.56
A and B	42.05	17.92	24.13
A, B & C	78.44	52.79	25.65
A, B, C & D	91.03	74.18	16.85
D and F	21.56	47.21	25.65
Failures	8.9	25.82	16.85

TABLE VIII. THE DISTRIBUTION OF DIFFERENCES IN PERCENTAGES BETWEEN THE GRADES OF STUDENTS HAVING HAD HIGH SCHOOL CHEMISTRY AND THOSE WHO HAVE NOT HAD HIGH SCHOOL CHEMISTRY DURING THE FALL TERM 1930.

Grades	Students with H.S. Chem.	Students without H. S. Chem.	Difference of percents
A	13.5	8.8	4.7
A and B	47.3	38.4	8.9
A, B & C	79.2	73.5	5.7
A, B, C & D	92.6	87.9	4.7
D and F	20.8	26.5	5.7
Failures	7.4	12.1	4.7

1929 is relatively large while during the fall term the differences are relatively small. The probable error (1) was computed for each difference and was found to be so small (less than .01 in each case) that all differences were certainly significant.

Tables IX and X, page 16, show the same results in general, viz. that the chemistry course 101 has increased the average number of points made by the students who have not had high school chemistry from .4787 to 1.088.

This is shown more clearly when the following data are compared. These data were taken from tables III, IV, IX and X. When first term chemistry students who have not had high school chemistry are competing in the same classes with students who have had high school chemistry, the average number of points made by the former are .478, while the students who have had high school chemistry average 1.22 points, over two and one-half times as many. The above averages were for the years 1920 to 1929 inclusive.

After the classes were separated into two groups, those taking course 101 and those taking 101a, the average numbers of points were nearly equal because the average number of points made by the students taking course 101 in the fall term of 1930 was 1.088 while the students taking course 101a averaged 1.33.

(1) See Appendix, Page 27-28, for probable errors and method of computations.

TABLE IX. DISTRIBUTION BY POINTS MADE BY THE STUDENTS IN FIRST TERM CHEMISTRY IN COURSE 101a AT MICHIGAN STATE COLLEGE DURING THE FALL TERM OF 1930. (STUDENTS HAVING HAD HIGH SCHOOL CHEMISTRY.)

Grade	Number of points	Number of students	Aggregate number of points	A and B only	A, B and C
A	3	82	246	246	246
B	2	205	410	410	410
C	1	193	193		193
D		81			
F	-1	45	-45		
Totals		606	805	656	847
Averages			1.33	2.28	1.77

TABLE X. DISTRIBUTION BY POINTS MADE BY STUDENTS IN FIRST TERM CHEMISTRY IN COURSE 101 AT MICHIGAN STATE COLLEGE DURING THE FALL TERM OF 1930. (STUDENTS NOT HAVING HAD HIGH SCHOOL CHEMISTRY.)

Grade	Number of points	Number of students	Aggregate number of points	A and B only	A, B and C
A	3	16	48	48	48
B	2	54	108	108	108
C	1	64	64		64
D		26			
F	-1	22	-22		
Totals		182	198	156	220
Averages			1.088	2.228	1.642

PART IV

DETERMINATION OF THE TREND OF ACCOMPLISHMENT OF FIRST TERM
CHEMISTRY STUDENTS AT MICHIGAN STATE COLLEGE DURING
A TEN YEAR PERIOD, 1920 to 1929 INCLUSIVE

Table XI, page 18, is compiled from table XII in the appendix and shows that the trend of accomplishment over two five-year periods is for first term students to average a smaller number of points during the second five-year period than during the first five-year period.

The difference in the average number of points earned is slight, being .0385 for the students having had high school chemistry and .0731 for the students not having had high school chemistry. Perhaps this means that there is not any significant difference.

A difference might be due to any of one or a combination of the following factors: (a) difference in the aims of the course of study of the high schools or the college, (b) different text books, (c) a more comprehensive course in the college, (d) more activities in the high school, (e) lower standards in teaching arithmetic in the grades and other reasons not known.

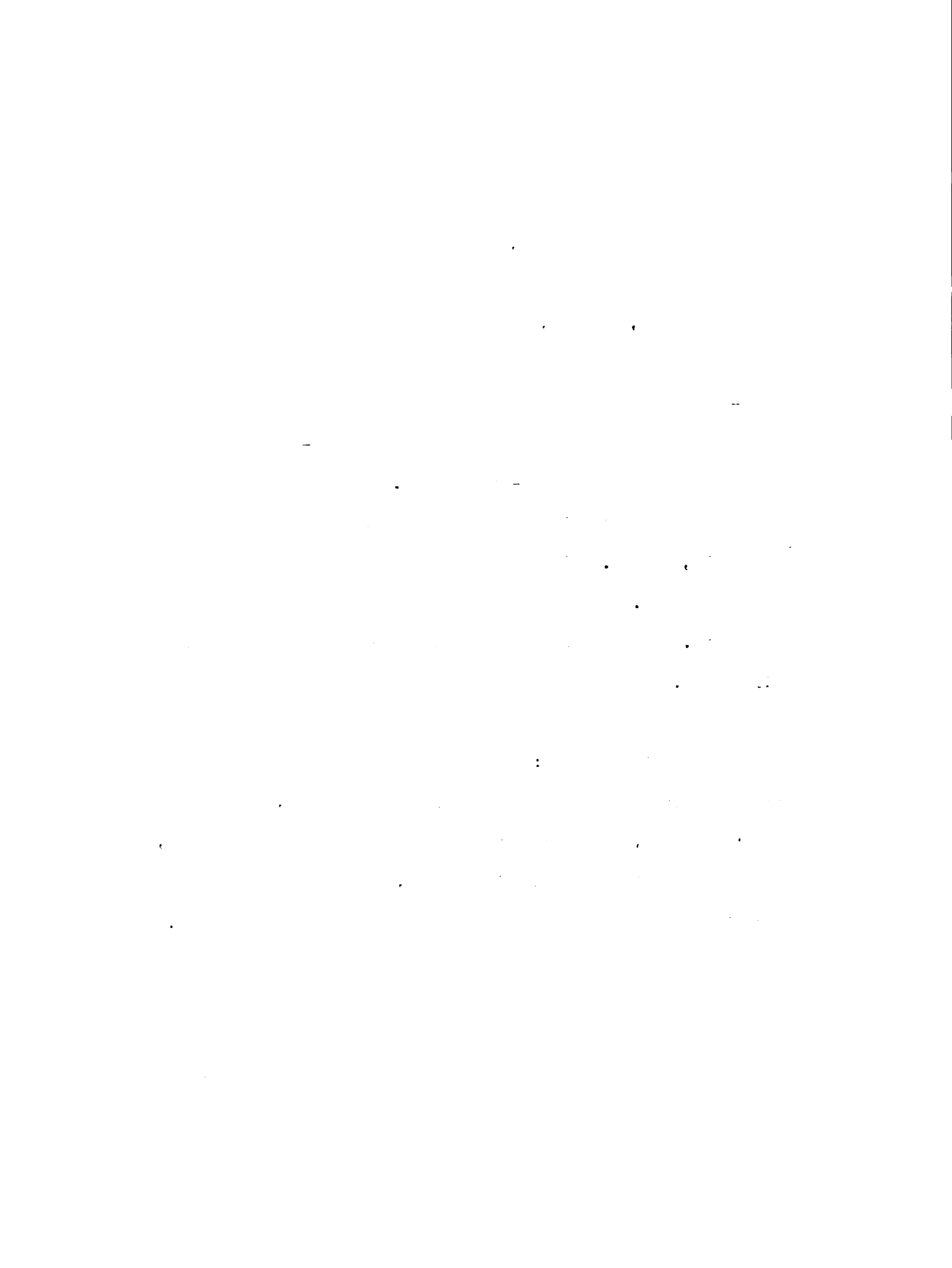


TABLE XI. COMPARISON OF AVERAGE POINTS MADE BY FIRST TERM
CHEMISTRY STUDENTS AT MICHIGAN STATE COLLEGE
DURING A DECADE 1920 to 1929 INCLUSIVE

	Average points made by students having had chemistry in high school	Average points made by students not having chemistry in high school
Five-year period 1920-1924	1.242	.524
Five-year period 1925-1929	1.2035	.4409

SUMMARY

Conclusions

Students who have had two semesters of chemistry in high school receive better grades in first term chemistry at Michigan State College than those who had no chemistry in high school, when no differentiation is made in the course of study. In the latter group there was 25.82 percent of failures, while in the group that had two semesters of chemistry in high school there was 8.97 percent of failures.

The differentiated chemistry course 101 for students who have had no chemistry in high school is valuable as far as the percentages of failures and the percentages of better grades are concerned. The percentage of failures of the students who had no chemistry in high school was reduced from 25.82 to 12.1. The percentage of failures of the students who had two semesters of chemistry, course 101a, reduced from 8.97 to 7.4. The plan of differentiating the first term chemistry classes was found to benefit both groups as far as better grades were concerned.

The trend of the accomplishment of first term chemistry students at Michigan State College (during a ten year period) is in the direction of lower grades. The difference is very slight and perhaps has no significance.

Limitations of this Study

Although the conclusions arrived at in part two were derived from a study over a ten year period and considered the grades of 6,817 students, the study of the success of the course 101 adopted in the fall of 1930 is limited to one term and considers the grades of only 788 students. The fact that students with a definite predilection for chemistry will elect the subject in high school while others not interested in science will not elect it, will probably have some weight on their success in the subject in college. The students with an interest in science should earn better grades than those who must take the subject as a course requirement. These conditions would tend to increase the percentage of failures of the students who did not have chemistry in high school and to decrease the percentage of failures of the other group.

The study of high school physics and of high school mathematics is pointed out by Dr. Wakeham⁽¹⁾ to aid students in first term chemistry. These factors were not considered in this study.

Suggestions for Further Study

To determine whether or not the study of chemistry in high school has any effect on accomplishment of students

(1) Glen Wakeham, School and Society, XXXII (August 9th, 1930) p. 207

taking advanced work in college chemistry.

To determine the trend of accomplishment of first term chemistry students during a period of years based on one year periods. This study covered a period of ten years and the conclusions were based on two, five year periods.

To study the accomplishment of students in first term chemistry from individual high schools.

To study the effect of high school physics and high school mathematics on accomplishment of first term chemistry students.

21a

A P P E N D I X

TABLE XII. TABULATED RESULTS FROM DR. WAKEHAM'S PAPER⁽¹⁾

Year	Number of students having had high school chemistry	Average grade first quarter	Number of students not having high school chemistry	Average grade first quarter
1922-23	243	77.3	194	77.1
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

(1) Glen Wakeham, School and Society XXXIII (August 9th, 1930)
p. 207

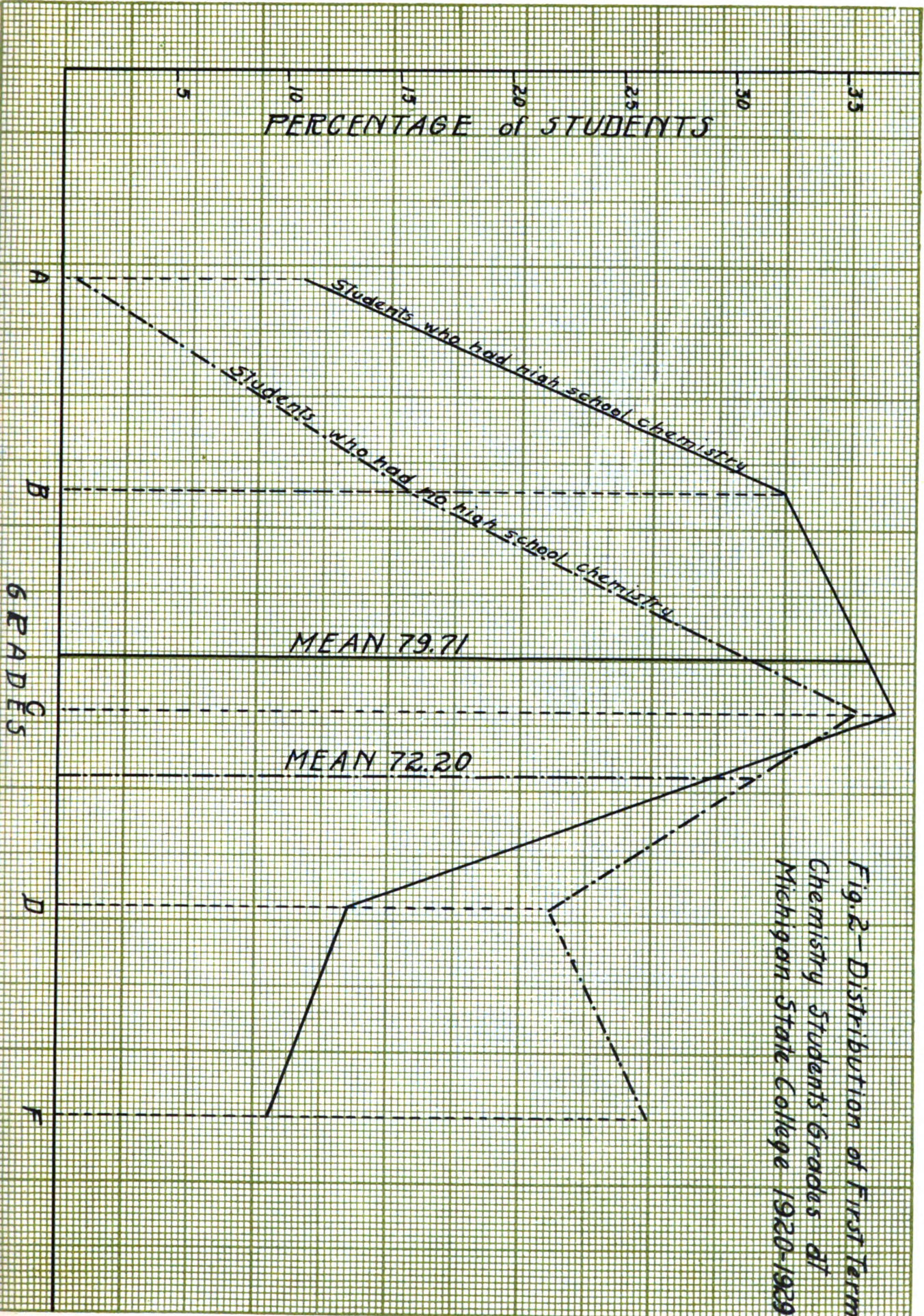


Fig. 2—Distribution of First Term Chemistry Students' Grades at Michigan State College 1920-1929

TABLE XIII. SUMMARY OF DATA COMPILED FROM THE FILES
OF THE CHEMISTRY DEPARTMENT OF MICHIGAN STATE
COLLEGE

Grades of first term chemistry students who have had two semesters of high school chemistry		Grades of first term chemistry students who did not have two semesters of high school chemistry		
	1920-1924 inclusive	1925-1929 inclusive		
			1920-1924 inclusive	
			1925-1929 inclusive	
A	165	297	24	25
B	628	753	108	138
C	747	848	283	291
D	224	328	157	195
F	137	256	178	247
Total	1901	2482	750	896

TABLE XIV. SUMMARY OF DATA COMPILED FROM THE YEARLY
RECORD BOOKS OF THE CHEMISTRY DEPARTMENT OF
MICHIGAN STATE COLLEGE

Grades of students taking chemistry course number 101		Grades of students taking chemistry course number 101a	
A	16		82
B	54		205
C	64		193
D	26		81
F	22		45
Total	182		606

Note: Chemistry course 101 is a 4 credit course for students who did not have chemistry in high school. Chemistry course 101a is a 3 credit course for students who have had two semesters of high school chemistry. For a brief description of the two courses, see page 5.

METHOD USED TO COMPUTE THE PROBABLE ERROR OF
DIFFERENCES OF PERCENTAGES

From Table V, page 13 was found that the percentage of students receiving a grade of A in course 101a was 13.5 and from Table VI, page 13 the percentage of students receiving a grade of A in course 101 was 8.8. The difference in percentage was 13.5 - 8.8 or 4.7.

Using the following formula. (1)

$$\text{P. E. difference in percentages} = \pm .6745 \sqrt{\left(\frac{P_1 \times (1-p_1)}{N_1}\right)^2 + \left(\frac{P_2 \times (1-p_2)}{N_2}\right)^2}$$

$$\text{Substituting P.E.} = \pm .6745 \sqrt{\left(\frac{.135 \times .865}{606}\right)^2 + \left(\frac{.088 \times .912}{182}\right)^2}$$

Solving P. E. = .000315

the difference of percentage = 4.7 \pm .000315

PROBABLE ERRORS DISCUSSED ON PAGE 15.

The probable errors for the difference of percents in Table VII are given below:

Grades	Difference of percents	Probable Error
A	7.56	$\pm .002$
A and B	24.13	$\pm .0000038$
A, B & C	25.65	$\pm .0001$
A, B, C & D	16.85	$\pm .000067$
D and F	25.65	$\pm .00000016$
Failures	16.85	$\pm .0000047$

Probable errors for Table VIII

Grades	Difference of percents	Probable Error
A	4.7	$\pm .000315$
A and B	8.9	$\pm .00092$
A, B and C	5.7	$\pm .00072$
A, B, C and D	4.7	$\pm .00000023$
D and F	5.7	$\pm .000415$
Failures	4.7	$\pm .000595$

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