HIGH SCHOOL PHYSICAL SCIENCE AS PREPARATION FOR COLLEGE SCIENCES

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CHAPTER I

INTRODUCTION

The traditional support for physics and chemistry in the high school curriculum has been stated in terms of preparation for college. However, with the great increase in enrollment in secondary schools in recent years has come the realization that only a small part of the secondary school population will continue further study of chemistry or physics in college. Hence, many high school chemistry and physics teachers are accepting the fact that the chief function of their courses is no longer that of college preparation (22, pp.633-47). Referring to recent research in the teaching of science, Mallinson (26, pp.321-42) stated:

> Much of the research has been carried out upon the assumption that the major objectives of the teaching of science are the functional understanding of the principles of science considered to be of value for general education, the development of the scientific attitudes, and the training in the skills of the scientific method.

If the major objectives of science teaching mentioned by Mallinson were achieved in the secondary school, would that not constitute the best possible preparation of the student for further science study in college? A college

physics teacher once stated that students would be better prepared for college physics if high school teachers would stop teaching physics from a college preparatory point of view. This statement implies that the science objectives which are of greatest value in attaining the goals of general education can also be of value as preparation for college science.

Even though preparation for college science is no longer accepted as a major objective of high school physics or chemistry by most teachers, it is nevertheless an important "by-product" which accompanies the attainment of the major objectives of science in general education; and the degree to which high school chemistry and physics affect success in those same subjects in college is still an important and controversial question.

Statement of the Problem

The general problem in this study was to find what relationship, if any, existed between success in college chemistry and physics and the student's high school preparation in these subjects. More specifically, the problem resolved itself into the following parts:

1. What are the findings of other studies in regard to the relationship between success in college chemistry and physics and the student's high

school preparation in these subjects?

2. What does a local study of Corvallis High School students who enrolled in chemistry and physics at Oregon State College show in regard to the relationship between success in college chemistry and physics and the student's high school preparation in these subjects?
3. What does a study of Oregon State College beginning students in chemistry and physics show in regard to the relationship between success in college chemistry and physics and high school preparation in these subjects?
4. Does the total study give any indication of what might be done to improve high school chemistry and physics courses so that they might effectively attain the objectives of general education and simultaneously provide an effective background for further work in college science?

Importance of the Problem

The effectiveness of high school chemistry and physics as preparation for these same subjects in college has long been a highly debatable subject. It is often asserted that it makes little, if any, difference whether or not a student has taken high school chemistry or physics

insofar as his attainment in those same subjects in college is concerned. The truth or falsity of this assertion is naturally of deep concern to high school science teachers and counselors.

The writer believes this study has significance from a guidance standpoint. The importance of more adequate predictive criteria in regard to a student's probable success in college physics or chemistry was brought out by Adams' study (1, p.3) from which the following is quoted:

> In a recent year, 299 students registered for one of the beginning physics courses at Louisiana State University. Of this group 38 either failed on the first semester's work or withdrew during this term. Since this course is basic in several curricula, this probably means that many of these 38 had to revise their vocational plans during or after their sophomore year. . . . .had these 38 known more about the relationships between success in college physics and achievement along more familiar lines, they might have been spared a great deal of mental suffering. Also they might have been spared the expense, in time and money, associated with a change in vocational plans at such a late date. (7:31)

At Oregon State College, out of a total of 180 students enrolled in the 1952 fall term of freshman engineering physics, 32 either failed or withdrew while another 35 received a D grade. Seventy-six out of 324 students enrolled in the fall term of one section of beginning chemistry either failed or withdrew during the term.

If certain basic relationships between various

features of the student's high school scholastic record and his probable success in college physics and chemistry could be established, perhaps much of the waste of the student's time and resources mentioned by Adams could be avoided through proper guidance.

Location of the Study

The study was made at Corvallis, Oregon, the location of Oregon State College, an institution of approximately 5,000 enrollment. Corvallis High School is a five year high school with a present enrollment of 1,075 students and 52 teachers. The high school science program consists of general science, biology, advanced biology, chemistry, physics, and aeronautics.

Subjects Employed in the Study

The study began with 566 students who graduated from Corvallis High School in the years 1944 to 1951 inclusive and who entered Oregon State College. Out of the 566 students, 116 were found to have incomplete high school records and had to be deleted. This left 450 students whose records at Oregon State College were further traced. From the records of the Oregon State College Chemistry Department, it was found that 118 students out of the 450 had registered for one or more terms of college general

chemistry, (Ch.101, 201, or 204). Likewise, the Oregon State College Physics Department records revealed that 55 students out of the 450 had registered for one or more terms of college general physics or engineering physics.

In addition to the study of the Corvallis High School graduates who attended Oregon State College, a questionnaire study was made involving a sample of 172 Oregon State College students enrolled in general chemistry and 75 Oregon State College students enrolled in engineering physics. Both samplings were taken during the latter part of the 1953 winter term. Since the Oregon State College sample included students from a widely scattered area, data collected from them should represent a large number of high schools. It was felt that a study including students from a variety of high schools would be a valuable supplement to the statistical study of Corvallis High School students. Also, the questionnaire made it possible to get student opinions, something which could not be done in the statistical study of Corvallis High School students.

Procedure of Solution

The procedure of solution of the problem was divided into three parts:

1. A survey of related studies was made and the

conclusions were summarized and compared.

2. A statistical study was made of the high school and college records of Corvallis High School graduates who attended Oregon State College. The records in college chemistry and physics were compared for students with and without high school training in those same subjects. The abilities of the students as measured by intelligence tests and college entrance tests were also taken into consideration in the comparisons. Means and standard deviations were determined for each of the compared groups. Coefficients of correlation between various aspects of the students' high school and college records were also determined.
3. A questionnaire given to Oregon State College students in chemistry and physics called for statements of opinions as well as of facts. The responses to the questionnaires were tabulated and the results summarized and analyzed with the purpose of uncovering any significant facts related to the problem of high school science as preparation for college physical sciences.

Limitations of the Study

The following limitations have influenced the findings in the study:

1. The statistical study was limited to graduates of the Corvallis High School, 1944-51, inclusive.
2. The actual number of students involved in the study was reduced because of incomplete data, either at the high school or college level.
3. No attempt was made, because of the size of the group, to segregate the students on the basis of sections in Chemistry (Ch. 101, 201 and 204) and in Physics (eng. physics 101 and general physics 201).
4. The questionnaire study was limited to samples of Oregon State College students who were enrolled in general chemistry or engineering physics during the latter part of the 1953 winter term. The selections of the samples were made at the discretion of the cooperating Oregon State College faculty members who distributed the questionnaire, and the samples are assumed to be random and representative of the students enrolled in general chemistry and engineering physics during the winter quarter. Those

students who had failed the first quarter and who were no longer enrolled in physics or chemistry were necessarily not included in the sampling. Limitation of time and lack of information on the location of many Corvallis High School graduates made it impossible to give the questionnaire to them.

CHAPTER II

RELATED STUDIES

Investigation of similar studies revealed a variety of results and conclusions. However, practically all of the studies did agree in one respect. All but one of the studies investigated showed some difference in achievement in college chemistry and physics in favor of those students who had studied the same subjects in high school. The disagreements were chiefly in regard to the amount and significance of the differences.

In the following discussion the studies pertaining to the effect of high school chemistry on success in college chemistry are grouped separately from those pertaining to physics. A third group of studies pertaining to prediction of success in college science is found in the latter part of the chapter. The chemistry and physics studies are listed chronologically.

Studies in the Field of Chemistry

In the field of chemistry, one of the earliest studies noted was the one conducted by Powers (27, pp.53-61) at Columbia University in 1924. He administered tests representing the field of chemistry to college chemistry students and found no great difference between

tha abilities of those students who had studied chemistry in high school and those who had not. Powers concluded:

> Much of the instructional effort in high school chemistry is misspent since the tests show that those abilities, the accomplishment of which is set as the objectives of instruction, are, even to the meagre extent to which they are mastered, once acquired, rapidly forgotten.

It might be noted that a difference was found in ability to do the tests in favor of the students with high school chemistry, but Powers did not consider it significant.

Wakeham (34, pp.739-40) made two studies of the effect of high school chemistry on success in college chemistry. Both studies were made in Colorado. In his first study, published in 1930, he concluded that there was very little difference, actually less than one per cent, between the college general chemistry grades of students who had taken high school chemistry and those who had not. In his second study published in 1935, Wakeham found that the grades of college general chemistry students who had studied high school chemistry averaged 12% higher than the grades of the group without high school chemistry. The discrepancy between the results of Wakeham's first and second studies is considerable; however, Wakeham considered his second study "a more searching investigation" and one whose results should be considered more reliable than those of his earlier study.

Wakeham further found that in the period 1922 to 1929 one-half of the freshmen college chemistry students at the University of Colorado had taken high school chemistry while during the period 1930 to 1933, over four-fifths had taken high school chemistry.

In his second study, Wakeham (34, p.740) stated that a student who had taken high school chemistry had an 85% chance of passing college chemistry, while the student who had not taken high school chemistry had barely a "fifty-fifty" chance.

Wakeham also studied the effect of other factors besides high school chemistry upon achievement in college chemistry. For a comparison of the effects of these various factors, the writer deemed it worth while to include the following table from Wakeham's second study:

SECOND STUDY (WAKEHAM)

Number of Students in each group	Average Grades in General College Chemistry in %
All (2,026) in a five-year period	77.0
1,681 who had taken high school chemistry	78.9
345 who had not taken high school chemistry	66.9
1,615 who had taken high school physics	77.8
411 who had not taken high school physics	73.6
1,349 who had taken high school chemistry and physics	79.5
38 who had not taken high school chemistry or physics	56.0
413 who had taken high school advanced algebra	76.8

It is interesting to note from Wakeham's table that high school physics as well as high school chemistry seemed to have a considerable effect on achievement in college chemistry.

The fourth study to be considered was made by Foster (15, pp.743-46) in 1938. His study was made of the records of first year chemistry and physics students at Nebraska State Teacher's College at Kearney, Nebraska, over a five-year period. He did not state the number of students involved in his chemistry study but reported a coefficient of correlation of .63 between high school and college chemistry grades compared with a coefficient of correlation of .607 between intelligence and college chemistry grades. Foster concluded that high school chemistry does have some effect on success in college chemistry. This is a logical conclusion since he found a higher correlation between high school and college chemistry grades than between intelligence and college chemistry grades.

The most recent chemistry study noted was made by Hoff (21, pp.539-42) in 1947. Hoff's study included 346 general chemistry students at State Teacher's College of La Crosse, Wisconsin, and covered a period of three years. Of the 346 students, 92 had not studied chemistry in high school. In his analysis, Hoff classified the

students into quartiles based on the formula:

$$\frac{2 \times \text{H.S. percentile rank} + \text{A.C.E. percentile rank}}{3}$$

This formula combines two success factors, habits of study and scholastic aptitude, with double weight on past achievement.

When the grades in college general chemistry achieved by students with and without high school chemistry were compared, Hoff found that the group who studied high school chemistry showed an advantage of 2.73% over the students who had not studied high school chemistry. Based on the classification into quartiles by the formula given above, it was found that the high school chemistry group showed superior scholastic ability over the group without high school chemistry to the extent of 1.69%. Upon equalizing the abilities of the two groups, Hoff calculated that the students who had studied chemistry in high school maintained an advantage of 0.83% in college chemistry. Hoff stated two conclusions from his study:

1. The investigation indicates that the study of chemistry in high school has no significant beneficial effect on the grades achieved in college general chemistry.

2. A student has approximately a 50% chance of achieving the same grade in college chemistry that he received in high school chemistry.

Hoff's study is unique among the chemistry studies

in that it is the only one that endeavored to offset the effect of variation in student ability in the comparison of the college achievement of students with and without high school chemistry.

In summarizing the results of the five related studies pertaining to the effect of high school chemistry on success in college chemistry, the writer believes it is significant that all of them showed a difference in achievement in college chemistry in favor of the students who studied high school chemistry. Two of the investigators called the difference in achievement in college chemistry significant, while three said it was insignificant.

Studies in the Field of Physics

In the field of physics, the earliest study investigated on the effect of high school physics on success in college physics was completed by Colmey (6, pp.1-90) in 1920. Colmey's study included 771 students who were enrolled in general physics at the University of Illinois during the years 1914 to 1919. In his study, Colmey used a questionnaire asking the student if he had taken high school physics and whether it had helped him in college physics. From the college records he obtained the college grades in physics for the entire group. His general

conclusions were that high school physics was of no benefit to those students whose records were examined at that time and he further recommended that there should be no segregation of students in college classes on the basis of whether they had or had not taken high school physics. Colmey's study was the only one noted which found no difference in college physics achievement between those students who had studied high school physics and those who had not. The results of this study are all the more interesting when notice is taken of the fact that it was made during the years when high school students were considered a much more select group than at present and preparation for college was still considered the most important function of high school courses.

The next physics study noted was completed in 1922 by Foley (14, pp.601-12). His study consisted of a survey of the grades of samples of first year physics students at nine different colleges located in the Central States. A tabulation of the results of Foley's survey is shown on the following page.

It is interesting to note in the tabulation that at Indiana State Normal the students without high school physics averaged 6% higher in college physics than the students who took high school physics. The other seven schools showed an advantage in college physics grades in

favor of those students who had studied high school physics. This illustrates the point that a single study dependent on a small sampling of students can lead to conclusions which conflict with those obtained from a larger number of studies and a larger sampling.

SURVEY OF PHYSICS GRADES (FOLEY)

Institution	Students with H. S. physics		Students without H. S. physics	
	No.	Col. Phys. Grade %	No.	Col. Phys. Grade %
Central Normal College	4	87	7	85.1
DePaw University	21	86.5	7	83.2
Earlham College	14	80	8	78
Indiana University	235	71.9	66	67.6
Rose Polytechnic Institute	65	80.1	21	76.3
Indiana State Normal School	17	82.5	4	88.5
Valparaiso University	10	73.5	1	67.5
Wabash College	26	70.7	5	70
(Weighted Average)	392	77.7	119	72.6

Foley did not commit himself as to the significance of the 5.1% advantage in college physics grades which was held by the group with high school physics. However, the fact that the difference again favored the group with high school physics does have some significance.

In a somewhat later study published in 1936, Ham (18, pp.190-94) compared the effect of preparation in high school mathematics with the effect of preparation in high school physics on achievement in college physics. He concluded that high school physics had just as much

effect on the final college physics grade as did preparation in high school mathematics. Ham concluded:

> The common statement that high school physics has no value for those taking college physics is therefore not confirmed.

A study by Foster (15, pp.743-46) was mentioned under related studies in chemistry. His study published in 1938 also involved general physics students at Nebraska State Teacher's College of Kearney, Nebraska, and covered a period of five years. The high schools included in the study represented a cross section of central Nebraska. He did not state the number of students involved in the study. From his data, Foster worked out a number of correlation coefficients involving college general physics, high school physics, intelligence and high school mathematics. The following statistics summarize Foster's results:

CORRELATION STUDY (FOSTER)

Zero Order Correlations	Coefficient of Correlation	Probable Error
General Physics--Intelligence	.77	.038
General Physics--H.S. Physics	.74	.034
General Physics--H.S. Algebra	.69	.040
General Physics--H.S. Geometry	.66	.043
High School Physics--Intelligence	.34	.096
High School Physics--H.S. Math.	.66	.034
High School Mathematics--Intelligence	.49	.048

CORRELATION STUDY (FOSTER)--Continued

Partial Correlations of First Order	Coefficient of Correlation
General Physics--H.S. Physics, eliminating Intelligence (Intelligence held constant)	.79
General Physics--H.S. Mathematics, eliminating Intelligence	.62
General Physics--Intelligence, with H.S. Physics eliminated	.81
High School Physics--General Physics, with H.S. Mathematics eliminated	.53
General Physics--Intelligence, with H.S. Mathematics eliminated	.61
High School Physics--Intelligence, with H.S. Mathematics eliminated	.16

Second Order Correlations

General Physics--H.S. Physics, with all other factors eliminated	.70
General Physics--Intelligence, with all other factors eliminated	.77
General Physics--H.S. Mathematics, with all other factors eliminated	.13

The following is Foster's interpretation of his statistics:

> In interpreting these results, it must be kept in mind that the partial correlations give the most accurate picture of the situation, when the factor or factors partialed out, contribute to both the others, and that, if one or both variables remaining are causes of the variable or variables partialed out, there is somewhat too much elimination in the process. .....if we look at the partial correlation between high school physics and college physics, (.70) in which the factors of high school mathematics and intelligence are partialed out, we see that both the eliminated factors might reasonably be supposed to contribute to the two remaining and that the figures obtained should be fairly accurate.

We might make, then, the following interpretations from our data:

1. The influence of high school physics on success in college physics seems to be high.
2. The influence of native intelligence seems to be still higher.
3. But the influence of high school mathematics seems to be negligible.

The zero order coefficient of correlation between high school and college physics grades obtained by Foster seems quite high compared to the coefficient of .324 obtained by Adams (1, p.50).

The next study to be considered was made by Rudy (30, pp.210-213) at West Virginia University during a five year period, 1935 to 1940. His study included 1,452 cases which is the largest number noted among the physics studies. A few explanations should be made before listing some of the data from Rudy's study. Rudy explained that the first year physics course titles at West Virginia University differed somewhat from the usually accepted course titles. Introductory physics at West Virginia University corresponds to general physics at most colleges while the course that is commonly known as engineering physics is called general physics at West Virginia. In all the following tables quoted from Rudy's studies, letter grades were translated into numerical values as follows: A=5, B=4, C=3, D=2, and F=1. The table on the following page shows a comparison of the

marks made in introductory physics at West Virginia University by the students with previous training in high school physics and the students without previous training in high school physics:

COMPARISON OF MARKS IN INTRODUCTORY PHYSICS (RUDY)

	Students with Training in H.S. Physics	Students without Training in H.S. Physics
Number of Students in Each Group the First Semester	406	562
First Semester Mean	3.638	3.363
Standard Deviation	1.019	1.069
Standard Error of Each Man	0.0505	0.0450
Number of Students in Each Group the Second Semester	359	481
Second Semester Mean	3.779	3.548
Standard Deviation	1.025	1.082
Standard Error of Each Mean	0.0540	0.0493

Further analysis of Rudy's data gives a low standard error of the difference between the two means in each case and a high critical ratio, which indicates high reliability in his results. Standard error between the difference of each pair of means and the critical ratio for the data in each table is given in the original reference (30, pp.210-213).

The next table shows a comparison of the marks made in general physics at West Virginia University by the students with previous training in high school physics and the students without previous training in high school

physics.

COMPARISON OF MARKS IN GENERAL PHYSICS (RUDY)

	Students with training in H.S. Physics	Students with no training in H.S. Physics
Number of Students in Each Group the First Semester	274	210
First Semester Mean	2.774	2.414
Standard Deviation	1.006	1.084
Standard Error of Each Mean	0.0607	0.0748
Number of Students in Each Group the Second Semester	245	173
Second Semester Mean	2.730	2.531
Standard Deviation	1.077	1.151
Standard Error of Each Mean	0.0688	0.0875

In the table just given it is interesting to notice that, while there was a drop in the mean grade from the first to the second semester for the group with high school physics, there was a rise in mean grade for the group with no training in high school physics. This shows that the advantage held by students with high school physics became less marked during the second semester of college physics.

The following conclusions and recommendations are quoted from Rudy's study:

> From this study it was found that as far as grades were concerned the students at West Virginia University with high school physics training did better in first year college physics than the students without previous high school physics.
>
> It might also be concluded that, since the difference between the means for the first

> semester's work is greater than the difference between the means for the second semester's work, the advantage held by the student with high school physics becomes less significant during the second semester.....the writer feels justified in recommending that high school physics be taken by pupils who plan to take physics in college. This does not mean that high school physics should be strictly college preparatory. It is the belief of the writer that the high school physics course can be made valuable to high school pupils who do not plan to enter college as well as to those who are planning to enter college. .....a course in high school physics should not only help prepare the pupil for college physics, but should be practical enough to appeal to pupils who are not going to enter college.

In view of the large number of cases employed in Rudy's study, it would seem justifiable to place considerable confidence in his results and conclusions.

The final and most recent study noted in the field of physics was completed by Adams (1, pp.1-100) in 1950. He made a study of 877 general physics students enrolled at Louisiana State University during the years 1947 to 1950 inclusive. The table on the following page gives a comparison of mean year marks which were determined according to the following scale: Two semesters of A were assigned a year mark of 8, two semesters of B a year mark of 6, two semesters of C a year mark of 4, two semesters of D a year mark of 2 and F was assigned a year mark of zero.

The following table summarizes Adams' findings:

COMPARISON OF COLLEGE PHYSICS MARKS (ADAMS)

	Number of Students	Mean Year Mark	Sigma
With High School Physics	367	4.856	1.81
Without High School Physics	509	4.758	1.73

Adams did not consider the difference in achievement in college physics between the students with and without high school physics significant.

Adams also worked out the coefficients of correlation between college physics marks and various phases of the high school records. The following table summarizes his findings:

CORRELATION STUDY (ADAMS)

Item from High School Record	Number of Students	Coefficient of Correlation	Probable Error
Physics	367	.324	.032
Rank in class	518	.306	.027
Algebra II	506	.290	.028
Math. Average	655	.279	.041
Chemistry	498	.263	.037
Senior English	622	.247	.037
English Average	659	.271	.025
Science Average	607	.204	.026

The coefficient of correlation between high school and college physics obtained by Adams seems quite low compared with other studies. Notice that high school mathematics has a lower coefficient of correlation with

college physics than does high school physics. This finding agrees with Foster's (15, pp.743-46) results.

In summarizing the results of the six related studies pertaining to the effect of high school physics on success in college physics, the writer believes it is significant that five out of six studies showed a difference in achievement in college physics in favor of the students who studied high school physics. Two of the investigators called the difference in achievement in college physics significant while two said it was insignificant. Two others did not express a definite opinion as to the significance of their results.

Studies on the Prediction of Success in Science

The number of failures in college science, especially in physics and chemistry, has long been a problem. Perhaps a large number of these failures could be prevented through guidance if more were known about the relationship between the available information about the student and his probable success in college science. The final group of studies discussed briefly below are chiefly concerned with the problem of prediction of success in college science.

In his endeavor to determine what information from

a student's record would serve as the best criterion of the student's success in college science, Gilkey (17, pp.576-88) worked out a number of correlation coefficients. He found an extremely low coefficient of correlation, .15, between high school and college marks in science. Gilkey reached the conclusion:

> If some type of achievement test could be devised which would measure persistence, effort, determination, mental attitude, interest and memory in addition to mere ability to learn, we should approach the solution to the problem.

Four years after Gilkey's study was published, Edds and McCall (10, pp.127-30) reported a relatively high coefficient of correlation, .63, between high school grade point average and grades in college laboratory science. For the purpose of comparison the complete list of correlation coefficients is quoted:

High School G.P.A. and English in College	.59
High School G.P.A. and College Lab. Science	.63
High School G.P.A. and College Mathematics	.48
High School G.P.A. and College Language	.53
High School G.P.A. and College G.P.A.	.65
Intelligence Tests and College G.P.A.	.44 to .6
H.S. Laboratory Science and College G.P.A.	.52

From the findings of Edds and McCall it appears that the student's high school grade point average stands among the best predictive criteria of his college marks in science. This is further substantiated by Smith (32, pp.167-76) who found that correlations between scores on

aptitude tests and college grades usually run between .40 and .55. Lauer and Evans (25, pp.159-60) found that high school grade point average was slightly superior to intelligence test records for prediction of first quarter college grades. This also agrees with the findings of Edds and McCall.

The remaining studies do not have a direct bearing on prediction of success in college science alone but are of interest from the standpoint of comparison with the previous studies.

Two studies published only a year apart, one by Douglas and Michaelson (8, pp.615-19) and the other by Schmitz (31, pp.465-73), agree that high school grade point average makes the best criterion of success in college. Schmitz also found that the American Council on Education Psychological Examination ranked second to high school grade point average as a criterion of college success. The coefficient of correlation of high school to college grade point average was .644 while the coefficient of correlation of the American Council Psychological Examination to college grade point average was .583.

Emme (11, pp.263-67) concluded from his study that rank in the high school graduating class seemed to be the best single criterion for predicting college success.

Ferguson's (12, pp.566-68) findings disagreed with those of the majority of investigators. He found a low coefficient of correlation, .30, between high school and college grades. He also found that entrance examinations, either psychological or academic, had a coefficient of correlation of .50 to .55 with grades in college and therefore were a better criterion for predicting college success.

The disagreement in values of coefficients of correlations between high school and college grade point averages just noted between Ferguson's and other studies may cause the reader to wonder if these coefficients have any meaning. Perhaps a study by Dressel (9, pp.612-17) can explain how such a variation might be caused. His study emphasized the existence of differences among high schools and indicated that prediction of college success could be improved by a knowledge of these differences.

As an illustration, Dressel compared the high school and college average grade ranks of 15 Michigan high schools represented below by letters:

High School	Rank on Basis of High School Average	Rank on Basis of Fall Term Average at Michigan State College
I	1	10
M	2	14
N	3	4
L	4	2
G	5	8
J	6	3
K	7	9
F	8	6
B	9	15
E	10	13
H	11	1
O	12	12
D	13	11
A	14	7
C	15	5

As can be seen from the great variation shown by these high schools in grading standards, the variations of the coefficients of correlation between high school and college grade point averages obtained in the various studies could very likely be at least partially ascribed to this difference in high schools.

In spite of variations, the results of a majority of the studies noted indicate that high school grade point average is the best single criterion for prediction of success in college science. Scores on the American Council of Education Psychological Examination ranked below high school grade point average as a predictive

criterion.

It was noted also that most of the writers recommended a multiple prediction formula based on the student's high school grade point average, intelligence test scores, aptitude test scores, and any other evidences of student ability and drive. It seems logical that it would be safer to depend upon several factors in estimating future scholastic success, rather than to depend on a single factor such as I.Q. or a college entrance test percentile.

CHAPTER III

THE STUDY

The opportunity to trace the records of his own students in college does not often present itself to a teacher of science. Under most circumstances, the time and means for making a follow-up study are not available. Here, in Corvallis, where the majority of the high school students taking further education attend Oregon State College, the opportunity to make such a study presented itself. Utilizing the high school and college records, the writer was able to obtain the data for his two follow-up studies. With the cooperation of the Oregon State College science departments, it was also possible to broaden the scope of the investigation beyond the writer's own group of students by means of a questionnaire distributed to first-year college science students.

The follow-up and the questionnaire studies will be considered in this chapter in the following order:

1. The follow-up study of Corvallis High School chemistry students.
2. The follow-up study of Corvallis High School physics students.
3. The questionnaire study of Oregon State College

beginning chemistry students.

4. The questionnaire study of Oregon State College beginning physics students.

Part I. A Follow-up Study of Corvallis High School Graduates Who Studied General Chemistry at Oregon State College

The records of 450 Corvallis High School graduates were traced at Oregon State College. Of this number, 118 were found to have been registered for one or more terms of general chemistry. For these 118 students, high school and college grades in chemistry, intelligence test scores, and high school grade point averages were secured from high school cumulative record cards and college chemistry department grade records. The decile ratings on the American Council on Education Psychological Examination were available from the Oregon State College Registrar's Office for 97 of the 118 students. The intelligence quotients listed on the high school cumulative record cards had been determined by either the Henmon-Nelson or California Tests of Mental Maturity. College and high school grade point averages were computed on the basis of four points for an A with a decrease of one point for each succeeding grade, ending with zero points for an F.

The collected data were tabulated in Tables I and II

found on the following pages. Students with and without high school chemistry were grouped separately in Tables I and II respectively. Within each grouping, the order of listing of the students was determined by college chemistry grade point average. By inspection of Table I, a considerable correlation can be noticed between college chemistry and high school chemistry grade point averages, and also between college chemistry and high school total grade point averages. The coefficient of correlation between college chemistry and high school chemistry grade point averages was .71, and between college chemistry and high school total grade point averages it was .67.

Before comparing the achievement in college chemistry of the students with and without high school chemistry, it was considered advisable to compare the abilities of the two sample groups. Table III shows the comparison of the two groups with respect to the mean I.Q.

TABLE I

DATA COLLECTED ON CORVALLIS HIGH SCHOOL GRADUATES WHO HAD STUDIED HIGH SCHOOL CHEMISTRY

Student Number	College Chemistry G.P.A.	Decile Rating on Q-Section A.C.E.	High School Chemistry G.P.A.	High School G.P.A.	I.Q. Rating
1	4.0	10	4.0	3.82	138
2	4.0	10	4.0	3.69	126
3	4.0	10	4.0	3.34	124
4	4.0	10	4.0	3.87	125
5	4.0	9	4.0	3.92	133
6	4.0	10	4.0	3.75	124
7	4.0	10	4.0	3.81	125
8	4.0	10	4.0	3.91	123
9	4.0	8	4.0	3.87	128
10	4.0	7	3.5	3.68	125
11	4.0	9	3.0	3.13	116
12	3.7	6	4.0	3.63	114
13	3.7	3	4.0	3.64	127
14	3.7	6	3.5	2.96	109
15	3.7	10	4.0	3.62	124
16	3.7	10	4.0	3.50	150
17	3.3	6	4.0	3.44	110
18	3.3	4	4.0	3.06	112
19	3.3	-	4.0	2.30	111
20	3.3	8	4.0	3.24	118
21	3.3	8	4.0	3.86	134
22	3.3	7	3.0	2.40	114
23	3.3	8	3.0	3.36	108
24	3.3	5	3.0	2.55	130
25	3.0	10	4.0	3.59	120
26	3.0	6	3.0	3.15	126
27	3.0	-	3.0	3.10	120
28	3.0	5	3.0	3.26	102
29	3.0	6	2.0	2.47	102
30	3.0	-	2.0	2.91	110
31	3.0	-	2.0	3.26	115
32	3.0	3	2.0	3.06	107
33	3.0	10	4.0	3.52	119
34	3.0	4	3.0	3.80	125
35	3.0	10	3.0	3.57	130

TABLE I (Continued)

Student Number	College Chemistry G.P.A.	Decile Rating on Q-Section A.C.E.	High School Chemistry G.P.A.	High School G.P.A.	I.Q. Rating
36	3.0	6	2.5	3.26	115
37	2.7	7	4.0	3.88	143
38	2.7	9	3.0	3.20	130
39	2.7	10	3.0	2.94	116
40	2.7	7	3.0	3.61	124
41	2.7	2	3.0	3.39	110
42	2.7	9	2.0	3.62	108
43	2.7	-	2.5	-	115
44	2.7	6	1.5	2.95	120
45	2.5**	8	4.0	3.61	136
46	2.5**	-	3.0	2.59	115
47	2.5**	-	2.0	2.87	125
48	2.3	9	3.0	3.38	137
49	2.3	10	3.0	3.24	151
50	2.3	7	3.0	2.88	100
51	2.3	8	2.0	-	137
52	2.3	8	2.0	2.50	113
53	2.3	7	2.0	2.94	132
54	2.3	-	2.0	3.39	127
55	2.3	6	3.0	3.79	120
56	2.3	6	1.0	2.30	105
57	2.3	2	1.0	2.74	110
58	2.0	3	3.0	2.30	109
59	2.0	3	3.0	3.03	110
60	2.0	3	3.0	2.48	111
61	2.0	6	2.0	2.60	130
62	2.0	7	2.0	2.18	117
63	2.0	6	2.0	3.27	109
64	2.0	8	2.5	3.08	123
65	2.0**	6	3.0	3.37	108
66	2.0**	8	3.0	2.41	103
67	2.0*	10	2.0	2.36	128
68	2.0**	5	2.0	2.08	115
69	2.0**	7	2.0	2.56	115
70	2.0*	9	2.0	2.06	102
71	2.0	5	0.5	2.25	104
72	1.7	8	2.0	2.10	125
73	1.7	4	2.0	3.37	110
74	1.7	10	1.0	1.80	127

TABLE I (Continued)

Student Number	College Chemistry G.P.A.	Decile Rating on Q-Section A.C.E.	High School Chemistry G.P.A.	High School G.P.A.	I.Q. Rating
75	1.5**	9	2.0	2.63	120
76	1.5**	2	2.0	2.22	106
77	1.3	5	2.0	2.78	116
78	1.3	10	2.0	2.63	125
79	1.3	6	2.0	2.25	102
80	1.0*	-	2.0	2.40	93
81	1.0*	7	1.5	1.88	105
82	1.0**	9	1.0	2.69	136
83	1.0*	7	1.5	2.21	102
84	0*	-	2.0	2.40	122

* Completed one quarter only
** Completed two quarters only

TABLE II

DATA COLLECTED ON CORVALLIS HIGH SCHOOL GRADUATES WHO HAD NOT STUDIED HIGH SCHOOL CHEMISTRY

Student Number	College Chemistry G.P.A.	Decile Rating Q-Section A.C.E.	High School G.P.A.	I.Q. Rating
1	4.0	10	4.00	141
2	3.7	7	3.96	118
3	3.3	10	2.34	112
4	3.3	-	3.50	132
5	3.3	10	3.72	135
6	3.3	6	3.30	117
7	3.3	10	3.75	127
8	2.7	7	2.30	119
9	2.7	7	3.87	115
10	2.7	3	3.70	110
11	2.3	5	2.96	119
12	2.3	10	3.62	120
13	2.3	-	2.80	120
14	2.0	-	2.89	132
15	2.0	7	1.80	122
16	2.0	-	2.50	96
17	2.0**	10	3.48	127
18	2.0*	5	3.83	139
19	2.0*	9	3.30	130
20	2.0*	9	2.68	120
21	1.7	10	2.38	115
22	1.5**	7	2.42	110
23	1.3	-	2.52	111
24	1.0	4	2.03	110
25	1.0**	3	2.70	110
26	1.0*	5	2.26	102
27	1.0*	1	2.55	106
28	1.0*	-	2.10	118
29	1.0**	-	2.10	95
30	.5**	-	2.17	105
31	.5**	5	2.00	118
32	0*	-	1.47	85
33	0*	-	2.00	95
34	0*	-	3.33	109

* Completed one quarter only
** Completed two quarters only

TABLE III

COMPARISON OF STUDENTS WITH AND WITHOUT HIGH SCHOOL CHEMISTRY IN RESPECT TO ABILITY AS MEASURED BY INTELLIGENCE TESTS

	Students with H.S. Chemistry	Students without H.S. Chemistry
Number of cases	84	34
Mean I.Q.	118.5	115.4
Standard Deviation	11.7	13.0

Table III indicates that the sample of the group with high school chemistry did show a slight superiority in intelligence. Translated into percentage the mean I.Q.'s differ by less than 3%. The mean I.Q.'s indicate that both samples are above average in intelligence.

Because some comparison of abilities in quantitative thinking was desired, the next comparison was based on the decile standings in the quantitative section of the American Council on Education Psychological Examination.

Table IV shows that the group with high school chemistry did show a slight superiority in mathematical ability as measured by the Q section of the A.C.E. test. Translated into percentage, the difference was less than 1.5%.

TABLE IV

COMPARISON OF STUDENTS WITH AND WITHOUT HIGH SCHOOL CHEMISTRY IN RESPECT TO ABILITY AS MEASURED BY THE QUANTITATIVE SECTION OF THE AMERICAN COUNCIL EXAMINATION

	Students with H.S. Chemistry	Students without H.S. Chemistry
Number of cases	74	23
Mean A.C.E. Decile on Q Section	7.1	7.0
Standard Deviation	2.44	2.62

According to the comparisons just completed, the sample of students with high school chemistry showed only slight superiority in intelligence and mathematical ability over the sample of students who had not studied high school chemistry. This difference in abilities is not large enough to be considered significant. These two samples were next compared with respect to college chemistry grade point averages.

Table V shows that the sample of students with high school chemistry held an advantage of 0.7 in mean grade point average in college chemistry over the sample of students without high school chemistry. Translated into percentage, the mean college chemistry grade point average of the students with high school chemistry was

more than 30% higher than the mean college chemistry grade point average of the students without high school chemistry.

TABLE V

COMPARISON OF STUDENTS WITH AND WITHOUT HIGH SCHOOL CHEMISTRY IN RESPECT TO GRADE POINT AVERAGE IN COLLEGE GENERAL CHEMISTRY

	Students with H.S. Chemistry	Students without H.S. Chemistry
Number of cases	84	34
Mean College Chemistry Grade Point Average	2.63	1.93
Standard Deviation	0.67	0.78

Summary and Conclusions of the Chemistry Follow-up Study

The sample of Corvallis High School students with high school chemistry held an advantage over the sample of students without high school chemistry to the extent of 3% in mean I.Q., 1.5% in mean decile on the Q section of the A.C.E. test, and 30% in mean college chemistry grade point average. This would indicate that, while the two groups were practically equivalent in ability, there was a considerable difference in their college chemistry grade point averages. Insofar as this sample was concerned, high school chemistry did seem to have a very significant effect on grades in college chemistry. This is a considerably greater difference than was found in previous studies. It is probably due to the following factors: the number in the sample group was smaller, only one teacher's methods and techniques of instruction were measured, and possibly the students were a more select group. The greatest difference in college chemistry grades for students with and without high school chemistry noted in the related studies was a 12% difference indicated by Wakeham (34, pp.739-40).

A difference in regard to the number of terms of college chemistry completed was also noted. It was found that 77.4% of the Corvallis High School students

who entered college and who had studied high school chemistry completed three terms of college chemistry while only 56% of the students without high school chemistry completed the three terms. Wakeham's (34, p.740) second study found that 85% of the students with high school chemistry completed the first year of college chemistry compared with 50% of the students without high school chemistry.

A study of the correlation of the high school and college chemistry grades of those Corvallis High School students who completed one year of college chemistry gave a correlation coefficient of .71. This is a substantial correlation and it compares quite well with the coefficient of .63 found by Foster (15, pp.743-6). The coefficient of correlation between high school grade point average and college chemistry grade point average was .67 for Corvallis High School students.

Part II. A Follow-up Study of Corvallis High School Graduates Who Studied Beginning Physics at Oregon State College

Fifty-five of the 450 Corvallis High School students whose records were traced at Oregon State College were found to have been registered for one or more terms of beginning physics. For these 55 students, high school and college grades in physics, intelligence test scores, and high school grade point averages were secured from high school cumulative record cards and college physics department grade records. The test deciles on the American Council on Education Psychological Examination were available from the Oregon State College Registrar's Office for 41 of the 55 students. The intelligence quotients listed on the high school cumulative record cards had been determined for the most part by the Henmon-Nelson and California Tests of Mental Maturity. College and high school grade point averages were computed on the basis of four points for an A, with a decrease of one point for each succeeding grade, ending with zero points for an F.

The collected data were tabulated in Tables VI and VII, found on the following pages. Students with and without high school physics were grouped separately in Tables VI and VII respectively. Within each grouping,

TABLE VI

DATA COLLECTED ON CORVALLIS HIGH SCHOOL GRADUATES WHO HAD STUDIED HIGH SCHOOL PHYSICS

Student Number	College Physics G.P.A.	Decile Rating on Q-Section A.C.E.	High School Physics G.P.A.	High School G.P.A.	I.Q. Rating
1	4.0	10	4.0	3.82	138
2	4.0	10	4.0	3.87	125
3	4.0	10	3.0	3.59	120
4	3.7	8	4.0	3.24	118
5	3.5**	9	3.0	3.13	116
6	3.3	10	4.0	3.52	119
7	3.0	10	3.0	3.72	135
8	3.0	10	4.0	3.50	150
9	3.0	6	4.0	2.96	109
10	2.7	-	4.0	2.90	106
11	2.5**	2	4.0	2.74	110
12	2.3	10	3.5	3.79	132
13	2.3	6	4.0	3.26	115
14	2.3	3	3.0	3.70	110
15	2.3	-	3.0	2.81	120
16	2.3	-	0.0	-	115
17	2.0	6	3.0	3.15	126
18	2.0	-	2.0	3.00	105
19	2.0	6	3.0	3.43	122
20	2.0	-	3.0	2.77	120
21	2.0	6	2.0	2.30	105
22	2.0	2	3.0	2.70	109
23	2.0**	3	3.0	2.30	109
24	2.0*	7	3.0	2.50	123
25	2.0*	7	2.5	3.07	127
26	2.0*	-	2.0	2.10	95
27	1.7	-	4.0	2.30	111
28	1.7	7	3.0	3.88	143
29	1.7	7	4.0	2.22	106
30	1.7	-	3.0	2.45	91
31	1.5**	10	2.0	2.36	128
32	1.5**	-	2.0	2.45	133
33	1.0*	6	2.0	2.60	130
34	1.0*	9	2.0	2.20	96
35	1.0**	7	2.0	2.56	115
36	0.5**	9	3.5	2.87	143
37	0	7	2.0	2.30	109
38	0	3	2.0	2.40	102

* Completed one quarter only
** Completed two quarters only

TABLE VII

DATA COLLECTED ON CORVALLIS HIGH SCHOOL GRADUATES WHO HAD NOT STUDIED HIGH SCHOOL PHYSICS

Student Number	College Physics G.P.A.	Decile Rating Q-Section A.C.E.	High School G.P.A.	I.Q. Rating
1	4.0	5	2.55	130
2	3.3	-	1.81	111
3	3.0*	10	2.34	112
4	3.0*	5	3.66	128
5	3.0*	10	3.24	151
6	2.7	7	2.30	119
7	2.5**	5	2.96	119
8	2.3	8	3.86	134
9	2.3	9	3.20	130
10	2.0	6	2.47	102
11	2.0*	-	3.29	123
12	2.0*	7	2.86	114
13	2.0	-	2.40	112
14	2.0	6	3.15	126
15	1.0*	10	3.57	130
16	1.0*	-	1.55	102
17	.0*	-	2.67	119

* Completed one quarter only
**Completed two quarters only

the order of listing of the students was determined by college physics grade point average. Inspection of Table VI gives some indication of the correlation between the various factors listed. The coefficient of correlation between college and high school physics grade point averages was .56, and between college physics and high school total grade point averages, it was .54.

Before comparing the achievement in college physics of the Corvallis High School students with and without high school physics, it was considered advisable to compare the abilities of the two sample groups. Tables VIII and IX show comparisons of the two groups with respect to mean I.Q.'s and mean deciles on the quantitative section of the A.C.E. test. The Q section of the A.C.E. test was used because a comparison of abilities in quantitative thinking was considered desirable.

Table VIII shows a slight difference in mean I.Q. of 3.64 in favor of the sample of students without high school physics. Translated into percentage, the mean I.Q. of the group without high school physics was very nearly 3% higher than the mean I.Q. of the group with high school physics. A comparison of the standard deviations indicate a slightly greater variation from the mean or a greater spread in the I.Q.'s for the group with high school physics. The mean I.Q.'s indicate that both

samples are above average in intelligence.

TABLE VIII

COMPARISON OF STUDENTS WITH AND WITHOUT HIGH SCHOOL PHYSICS IN RESPECT TO ABILITY AS MEASURED BY INTELLIGENCE TESTS

	Students with H.S. Physics	Students without H.S. Physics
Number of cases	38	17
Mean I.Q.	117.6	121.24
Standard Deviation	13.5	12.6

TABLE IX

COMPARISON OF STUDENTS WITH AND WITHOUT HIGH SCHOOL PHYSICS IN RESPECT TO ABILITY AS MEASURED BY THE QUANTITATIVE SECTION OF THE AMERICAN COUNCIL EXAMINATION

	Students with H.S. Physics	Students without H.S. Physics
Number of cases	29	12
Mean A.C.E. Decile on Q Section	7.0	7.4
Standard Deviation	2.6	2.1

Table IX shows a difference in mean A.C.E. decile on the Q section of 0.4 in favor of the students without high school physics. Translated into percentage, the

mean A.C.E. decile on the Q section for the group without high school physics was more than 5% higher than the mean decile for the group with high school physics.

According to the comparisons just completed, the sample of students without high school physics showed only slight superiority in intelligence and in mathematical ability over the sample of students who had studied high school physics. In addition, the sample of students with high school physics showed a slightly greater variation from the mean in both intelligence test scores and A.C.E. decile standings than did the sample without high school physics. However, the differences in abilities between the two groups are not large enough to be significant.

The same two samples of Corvallis High School students are next compared with respect to college physics grade point average.

Table X shows that the sample of students without high school physics held an advantage of 0.1 in mean grade point average in college physics over the students with high school physics. Translated into percentage, the mean college physics grade point average of the students without high school physics was over 4% higher than the mean college physics grade point average of the students with high school physics. The per cent of

difference in college physics grade point average parallels, almost exactly, the per cent of difference in the measured abilities of the two groups.

TABLE X

COMPARISON OF STUDENTS WITH AND WITHOUT HIGH SCHOOL PHYSICS IN RESPECT TO GRADE POINT AVERAGE IN COLLEGE PHYSICS

	Students with H.S. Physics	Students without H.S. Physics
Number of cases	38	17
Mean College Physics Grade Point Average	2.14	2.24
Standard Deviation	0.76	0.76

Summary and Conclusions of the Physics Follow-up Study

The sample of students without high school physics showed an advantage over the sample with high school physics to the extent of 3% in mean I.Q., 5% in mean decile on the Q section of the A.C.E. test, and 4% in mean college physics grade point average. These small differences indicate that the two groups were practically equivalent in ability and, insofar as this small sample is concerned, high school physics did not seem to have any noticeable effect on grades in college physics. The differences in college physics grades for those students with and without high school physics noted in the related studies ranged from no difference found by Colmey (6, pp.1-90) to a difference of 7% found by Rudy (30, pp.210-13) in favor of the students with high school physics.

Some difference was indicated in regard to the number of terms of college physics completed. It was found that 63% of the Corvallis High School students who studied high school physics completed three terms of college physics while only 47% of the students without high school physics completed three terms of college physics.

A study of the correlation of the high school and

college physics grades of those Corvallis High School students who completed one year of college physics gave a correlation coefficient of .56. This value lies between the coefficient of correlation of .74 found by Foster (15, pp.743-46) and .324 obtained by Adams (1, p.50). The coefficient of correlation between high school total grade point average and college physics grade point average was .54 for Corvallis High School students.

Part III. Questionnaire Study of Oregon State College General Chemistry Students

As was mentioned earlier, it was felt that a survey study including students from different high schools would be a valuable supplement to the statistical study which was limited to Corvallis High School students. In addition, since student reactions to questions pertaining to the study were desired, a questionnaire was considered the most practical device by means of which these student reactions could be obtained.

Two objectives of the questionnaire were stated at the top of each questionnaire. They were:

1. To determine the value, if any, of high school science to the college student of science.
2. To gather data that might make possible the improvement of high school science courses.

It was further stated on the questionnaire sheet that the data collected would be treated statistically without reference to individual students or schools.

Through the cooperation of the late Dr. Friedman of the Oregon State College Chemistry Department, the chemistry questionnaire was given to a sample of 172 general chemistry students during the latter part of the winter term of 1953. Eighty-one students of the sample

were enrolled in Chemistry 102, a course including students majoring in miscellaneous fields such as agriculture, home economics, and physical education. Forty-eight students were enrolled in Chemistry 202, a course especially designed for sophomores in engineering, and 43 were enrolled in Chemistry 205, the course taken by chemistry majors, chemical engineers, science majors, premedical and pharmacy students.

A copy of the questionnaire used is found in Appendix A.

The first three questions concerned the students' high school background. Table XI on the following page summarizes the responses.

Seventy-five per cent of the Oregon State College chemistry students sampled by the questionnaire had taken high school chemistry. This compares quite closely with the 71% of the Corvallis High School graduates enrolled in general chemistry who had taken high school chemistry.

TABLE XI

DATA DESCRIPTIVE OF THE SUBJECTS OF THE COLLEGE CHEMISTRY QUESTIONNAIRE STUDY

	Course Numbers 205	202	102	Total	Per cent of Total
Number of students with h.s. chemistry	41	37	51	129	75
Number of students without high school chemistry	2	11	30	43	25
Number of students with h.s. physics	29	42	24	95	55.2
Number of students with no h.s. chemistry or physics	1	3	24	28	16.3
Number of students with algebra, geometry, advance algebra and trigonometry in h.s.	13	40	10	63	36.6
Number of students with two or less courses in h.s. mathematics	16	3	43	62	36

Question four of the questionnaire asked for the first term grade in general chemistry in college. The grade distribution is shown in Tables XII and XIII for the students with and without high school chemistry:

TABLE XII

FIRST TERM COLLEGE CHEMISTRY GRADES OF STUDENTS WITH HIGH SCHOOL CHEMISTRY

College Chemistry Grades	A	B	C	D	Totals
Number of students in Chemistry 205	8	15	17	1	41
Number of students in Chemistry 202	5	21	10	1	37
Number of students in Chemistry 102	2	14	27	8	51
Totals	15	50	54	10	129
Per cent of total	11.6	38.8	41.8	7.8	100

TABLE XIII

FIRST TERM COLLEGE CHEMISTRY GRADES OF STUDENTS WITHOUT HIGH SCHOOL CHEMISTRY

College Chemistry Grades	A	B	C	D	Totals
Number of students in Chemistry 205	0	1	1	0	2
Number of students in Chemistry 202	0	6	5	0	11
Number of students in Chemistry 102	0	6	14	10	30
Totals	0	13	20	10	43
Per cent of total	-	30.2	46.5	23.3	100

First term failures are not shown in Tables XII and XIII because the students who failed the first term were no longer in the class when the questionnaire was administered during the winter term.

A comparison of Tables XII and XIII shows a considerable advantage in the number of A and B grades in college chemistry in favor of those students who studied high school chemistry. Excluding first term failures, the first term college chemistry mean grade point average of the group with high school chemistry was 2.54 compared to 2.07 for the group without high school chemistry. Caution should be taken in interpreting this

difference, since the students' abilities, aptitudes and interests have not been taken into consideration.

Question five of the questionnaire asked the student to classify first year college chemistry as to difficulty. The students checked one of three degrees of difficulty described as very difficult, of average difficulty, and easy. The following table summarizes the responses:

TABLE XIV

STUDENT OPINIONS OF THE DEGREE OF DIFFICULTY OF COLLEGE CHEMISTRY

	Very Difficult	Of Average Difficulty	Easy	Totals
Number of Students with H.S. Chemistry	15	105	8	128
Per cent of Total	11.7	82	6.3	100
Number of Students without H.S. Chemistry	18	23	2	43
Per cent of Total	41.8	53.5	4.7	100

Table XIV indicates that a much higher percentage of the sample of students without high school chemistry classified college chemistry as very difficult.

Question six applied to those students who did not

take physics in high school. The question asked, "To what degree do you feel that you were at a disadvantage in first year college chemistry as a result of not having had high school physics?" The responses to this question were checked as follows: A great deal of disadvantage - 6, some disadvantage - 20, very little disadvantage - 28, and uncertain as to disadvantage - 20. Better than one quarter of the responses here were uncertain. This would seem to indicate that many students did not feel themselves qualified to judge the value of a subject with which they were unfamiliar. Those who did express opinions were about equally divided as to the value of high school physics in college chemistry.

Question seven of the questionnaire asked the students who had studied high school physics to estimate to what extent it helped them in college chemistry. Seven said high school physics helped them a great deal in college chemistry, 38 said it helped them some, 42 said it helped very little, and six were uncertain. The majority opinion reflected here is that high school physics was not of great value to the study of college chemistry.

Question eight was directed to students who had not studied chemistry in high school. It asked the student to estimate the degree of disadvantage he felt in

first year college chemistry as a result of not having studied high school chemistry. In answer to this question 26, or 62%, said they felt they were at a very great disadvantage in college general chemistry as a result of not having studied high school chemistry; 14 said they felt they were at some disadvantage, two at very little disadvantage, and one was uncertain. These responses seem to indicate that most of the college chemistry students who did not study high school chemistry wished that they had done so.

Question nine consisted of several parts and was directed to students who had studied high school chemistry. Summaries of the responses to these questions are shown in the following tables:

TABLE XV

RESPONSES TO QUESTION 9(a).
HOW MUCH DID HIGH SCHOOL CHEMISTRY HELP YOU IN COLLEGE CHEMISTRY?

Chemistry Course	Degree of Help of H.S. Chemistry in College Chemistry				
	Very much	Some	Very little	Uncertain	Totals
205	21	13	6	0	40
202	14	17	3	3	37
102	27	17	7	0	51
Totals	62	47	16	3	128
Per cent of Total	48.4	36.7	12.5	2.4	100

The responses in Table XV indicate that, in the opinion of a large proportion of the college chemistry students in this sample, high school chemistry was of very much help. This may further indicate that, in most cases, there has been satisfactory articulation between high school and college chemistry courses.

TABLE XVI

RESPONSES TO QUESTION 9(b).
HOW WOULD YOU CLASSIFY HIGH SCHOOL CHEMISTRY AS TO DIFFICULTY?

Chemistry Course	Degree of Difficulty of High School Chemistry			
	Very Difficult	Of Average Difficulty	Easy	Totals
205	0	21	19	40
202	3	16	18	37
102	5	36	7	51
Totals	8	76	44	128
Per cent of Total	6.3	59.3	34.4	100

The responses to this question together with the general comments made by a number of students at the end of the questionnaire would certainly indicate that many college students felt that they should have worked harder in high school chemistry.

TABLE XVII

RESPONSES TO QUESTION 9(c).
DID THE STUDY OF HIGH SCHOOL CHEMISTRY HELP YOU
IN PLANNING YOUR COLLEGE COURSE?

Chemistry Course	Responses to Question			
	Yes	No	Uncertain	Totals
205	24	15	2	41
202	4	27	6	37
102	14	31	6	51
Totals	42	73	14	129
Per cent of Total	32.6	56.5	10.9	100

TABLE XVIII

RESPONSES TO QUESTION 9(d).
DID THE STUDY OF HIGH SCHOOL CHEMISTRY HELP YOU
IN DECIDING UPON A VOCATION?

Chemistry Course	Responses to Question			
	Yes	No	Uncertain	Totals
205	17	18	6	41
202	4	27	7	38
102	7	38	6	51
Totals	28	83	19	130
Per cent of Total	21.6	63.8	14.6	100

It is interesting to note that the students in chemistry 205, which is the section made up of chemistry majors, chemical engineers, science majors, premedical and pharmacy students, said with the greatest frequency that they were helped by high school chemistry both in planning their college course and in deciding upon a vocation.

TABLE XIX

RESPONSES TO QUESTION 9(e).
WHICH OF THE FOLLOWING PHASES OF
HIGH SCHOOL CHEMISTRY HELPED YOU MOST?

Phase of High School Chemistry	Number of Times Checked
Writing of formulas and equations	95
Vocabulary	62
Atomic structure	62
Periodic chart	44
Problem solving	38
Laboratory work	28
Applications of chemistry	22
Teacher demonstrations	3

The instructions to the student in answering question 9(e) were to check no more than three items. One hundred twenty-nine students checked from one to three items in the list. The large number of checks on the first item in Table XIX probably reflects the emphasis at the college level of this particular area of chemistry.

Question 9(f) was marked "Optional" on the questionnaire. It asked the student to suggest what might be done by the high school teacher to improve the high school course in chemistry. Eighty-six out of the 129 students who had studied high school chemistry made comments. Most of the comments were constructive rather than being merely critical or complimentary of the student's own high school course. The comment made with greatest frequency, 27 times, was that the high school chemistry course should emphasize problem solving including the solution of chemical equations. That the high school course should include more practice in writing chemical equations was suggested 21 times. Thirteen students suggested that more formula writing should be included and nine said there was a need for more emphasis of fundamental chemical laws and theories and their applications. Eight said there was a need for increasing the laboratory facilities and the amount of time for laboratory work in their high schools while three said there should be less laboratory work and more time for recitation and class discussion of the fundamentals of chemistry. More stress on atomic structure and valence was suggested by five students, while a few suggestions were made for more emphasis on solubility rules,

replacement series, ionic equations, balancing equations, and naming of compounds.

In making a general evaluation, 15 students said their high school chemistry course was "O.K.", "complete" or "at a very high level". Nineteen students stated that their high school chemistry course should have been "harder" or that "the students should study harder". Typical comments were, "be sure not to make high school chemistry too easy", "make it tougher", "don't let students slide by", "be more thorough and don't try to cover so much territory". Eight students stated there was need of a better teacher in their high school chemistry course. Typical comments were "the teacher should know more than the students", "the teacher should keep abreast of the field", "the teacher should give less memory work and more reasoning cultivation".

A significant thing noted from the comments was the large number of students calling for more of the problem solving type of work in high school chemistry. The great frequency of another comment seems to indicate that most high school chemistry courses do not require enough work of the student.

Summary of Chemistry Questionnaire Data

1. Seventy-five per cent of the sample of Oregon State College beginning chemistry students had studied chemistry in high school.
2. One hundred twenty-nine Oregon State College first year chemistry students who studied chemistry in high school had a mean college chemistry grade point average of 2.54. Forty-three Oregon State College first year chemistry students who did not study chemistry in high school had a mean college chemistry grade point average of 2.07.
3. Forty-two per cent of the group without high school chemistry classified college chemistry as very difficult compared with 12% of the group with high school chemistry who did so.
4. The opinions of Oregon State College chemistry students who lacked high school physics were about equally divided in regard to whether or not a lack of high school physics put them at a disadvantage in college chemistry.
5. There was about an even division of opinion among Oregon State College chemistry students who studied high school physics, in regard to whether or not high school physics helped them in college chemistry.

6. A large proportion, 93%, of the Oregon State College chemistry students who lacked high school chemistry felt they were at a disadvantage in college chemistry as a result of their not having studied high school chemistry.
7. Almost half, 48.4%, of the Oregon State College chemistry students who had studied high school chemistry said it helped them very much in college chemistry. Over a third more, 36.7%, said high school chemistry helped them some in college chemistry.
8. Very few college chemistry students who had studied high school chemistry, 6.3%, classified high school chemistry as very difficult. The majority, 59.3%, said that high school chemistry was of average difficulty and about one-third, 34.4%, thought high school chemistry was easy.
9. About one-third, 32.6%, of the college chemistry students who studied high school chemistry said that it helped them in planning their college course.
10. A little over one-fifth, 21.6%, of the Oregon State College chemistry students who studied high school chemistry said that the study of high school chemistry helped them in deciding upon a vocation.

11. The largest number of the Oregon State College chemistry students who studied high school chemistry checked "writing of formulas and equations" as the phase of high school chemistry that helped them most.
12. The comment made with greatest frequency by Oregon State College chemistry students who studied chemistry in high school was that high school chemistry courses "should include more problem solving".

Part IV. Questionnaire Study of Oregon State College Engineering Physics Students

A questionnaire very similar to that used in the preceding chemistry study was prepared and given to Dr. Decker of the Oregon State College Physics Department for distribution to a sample of 75 engineering physics students during the latter part of the 1953 winter term. A copy of the questionnaire used is found in Appendix B.

The first three questions concerned the students' high school background. The following table summarizes the responses:

TABLE XX

DATA DESCRIPTIVE OF THE STUDENTS SAMPLED BY THE COLLEGE PHYSICS QUESTIONNAIRE

	Number	Per cent of Total
Students with high school physics	66	88
Students without high school physics	9	12
Students with high school chemistry	57	76
Students without high school chemistry	18	24
Students with both high school chemistry and physics	56	74.8
Students with neither high school chemistry nor physics	8	10.7
Students with four years of high school mathematics (algebra, geometry, advanced algebra and trigonometry)	55	73.4

The high percentage of students with high school physics, chemistry, and four years of high school

mathematics indicates that most of the students of the sample possessed the recommended background for engineering.

The fourth question of the questionnaire asked for the first term grade in college physics. The grade distribution is shown below:

TABLE XXI

FIRST TERM COLLEGE PHYSICS GRADES OF STUDENTS WITH HIGH SCHOOL PHYSICS COMPARED WITH THOSE OF STUDENTS WITHOUT HIGH SCHOOL PHYSICS

College Physics Grade	A	B	C	D	F	Totals
Number of students with h.s. physics obtaining various grades	8	27	23	7	1	66
Per cent of Total	12.1	40.9	34.9	10.6	1.5	100
Number of students without h.s. physics obtaining various grades	1	2	3	3	0	9
Per cent of Total	11.1	22.1	33.4	33.4	0	100

The mean college physics grade point average of the students who had high school physics was 2.51 compared to a mean 2.11 college physics grade point average for the students who had no high school physics. However, the 2.11 mean cannot be considered reliable because of the small number of students in the sample.

Question five of the questionnaire asked the student to classify first year college physics as to difficulty. Fifty-six per cent of the group without high school physics classified college physics as very difficult, while 38% of the group who had studied high school physics classified college physics as very difficult. By comparison, less than 12% of the group who had studied high school chemistry classified college chemistry as very difficult. Possibly this means that a greater difference exists between the subject matter and teaching methods of high school and college physics courses than exists in the case of high school and college chemistry.

Question six applied to those students who did not study chemistry in high school. The question asked, "To what degree do you feel that you were at a disadvantage in first year college physics as a result of not having studied high school chemistry?" Sixty-five per cent said that they felt they were at very little disadvantage in college physics as a result of not having had high school chemistry. Evidently the lack of chemistry did not seem important in college physics.

Question seven of the questionnaire asked the students who had studied high school chemistry to estimate to what extent it helped them in college physics. The

following table summarizes the responses to the question:

TABLE XXII

STUDENT OPINIONS OF THE DEGREE OF HELPFULNESS OF HIGH SCHOOL CHEMISTRY TO THE STUDY OF COLLEGE PHYSICS

	Very much help	Some help	Very little help	Uncertain	Totals
Number of Responses	3	15	35	3	56
Per cent of Total	5.35	26.8	62.5	5.35	100

Again high school chemistry did not seem important to success in college physics as evidenced by college student opinion.

Question eight was directed to students who had not studied physics in high school. It asked the student to estimate the degree of disadvantage he felt in first year college physics as a result of not having studied high school physics. Two of the nine students who had not studied high school physics said they felt they were at a very great disadvantage in college physics, four felt they were at some disadvantage and the remaining three felt they were at very little disadvantage in college physics as a result of not having studied high school physics. No great significance can be attached to the division of the responses here because of the smallness of the sample.

Question nine was directed to students who had studied high school physics. It consisted of several parts. Summaries of the responses are shown in the following tables:

TABLE XXIII

RESPONSES TO QUESTION 9(a).
HOW MUCH DID HIGH SCHOOL PHYSICS HELP YOU IN COLLEGE PHYSICS?

	Very much help	Some help	Very little help	Uncertain	Totals
Number of Responses	8	37	20	1	66
Per cent of Total	12.1	56	30.4	1.5	100

The 12.1% of the sample of college physics students who indicated high school physics was of very much help in college physics compares with 48.4% of the sample of college chemistry students who indicated that high school chemistry was of very much help in college chemistry. This again seems to point to a poorer articulation between high school and college physics.

TABLE XXIV

RESPONSES TO QUESTION 9(b).
HOW WOULD YOU CLASSIFY HIGH SCHOOL PHYSICS AS TO DIFFICULTY?

	Very Difficult	Of Average Difficulty	Easy	Totals
Number of Responses	5	29	32	66
Per cent of Total	7.6	44	48.4	100

The responses to Table XXIV, together with a large number of comments made at the end of the questionnaire, indicate that more work should be required in high school physics.

TABLE XXV

RESPONSES TO QUESTION 9(c).
DID THE STUDY OF HIGH SCHOOL PHYSICS HELP YOU IN PLANNING YOUR COLLEGE COURSE?

	Yes	No	Uncertain	Totals
Number of Responses	18	39	9	66
Per cent of Total	27.3	59.1	13.6	100

TABLE XXVI

RESPONSES TO QUESTION 9(d).
DID THE STUDY OF HIGH SCHOOL PHYSICS HELP YOU IN DECIDING UPON A VOCATION?

	Yes	No	Uncertain	Totals
Number of Responses	12	39	15	66
Per cent of Total	18.2	59.1	22.7	100

Even though the percentage of yes responses to Tables XXV and XXVI were in the minority, the degree to which high school physics did help in student educational and vocational planning would still seem to be a worthwhile contribution to student guidance.

TABLE XXVII

RESPONSES TO QUESTION 9(e).
WHICH OF THE FOLLOWING PHASES OF HIGH SCHOOL PHYSICS HELPED YOU MOST?

Phase of High School Physics	Number of Times Checked
Learning basic principles	41
Learning about application of physics	20
Problem solving	13
Laboratory work	13
Learning subject vocabulary	9
Teacher demonstrations	8

It is interesting to notice that such a large number of students realized that learning basic principles is

probably the most important outcome of their physics courses.

Question 9(f) was marked "Optional". It asked the student to suggest what might be done by the high school teacher to improve the high school course in physics. Forty-three out of the 66 students who studied high school physics made comments. Two comments tied for first place in frequency. Fourteen students stated that the high school physics course should demand more work of the students. Typical comments were "require more of the student", "high school course was too easy", "make course more thorough", "go into more detail", "cover more material", "make course harder and require more study". Fourteen students commented that the high school physics course should put more stress on the basic principles. Nine students called for "more problem solving", "more difficult problems" or "more practical problems", in the high school physics course. Two students thought their high school physics courses were "fine" and needed no improvement. Three students said the high school physics course should be limited to those sincerely attempting to learn, and trouble makers should be eliminated. Other suggestions for the improvement of the student's high school course in physics

included, "more laboratory equipment and a better laboratory set-up", "more stress on applications of physics", "more stress on the use of units with all formulas", "have more derivations of formulas", "stress subject of motion", "be sure the student gets the fundamentals--don't just try to finish the materials in the book", and"make students do the thinking".

Again there is an indication from the frequency of the comments made that more work should be required of the high school physics student. A number of the comments indicated a desire for a type of high school physics course which emphasizes problem solving and reasoning.

Summary of Physics Questionnaire Data

1. Eighty-eight per cent of the sample of Oregon State College engineering physics students had studied high school physics. Very nearly 75 per cent of them had taken both high school chemistry and physics together with four years of high school mathematics.
2. The 66 Oregon State College engineering physics students who studied physics in high school had a mean college physics grade point average of 2.51. The nine Oregon State College engineering physics students who did not study physics in high school had a mean college physics grade point average of 2.11.
3. Fifty-six per cent of the Oregon State College engineering physics students who did not study physics in high school classified college physics as very difficult while 38 per cent of the group with high school physics did so.
4. Almost two-thirds, 65 per cent, of Oregon State College engineering physics students who did not study high school chemistry said that the lack of high school chemistry was of very little disadvantage in college physics.

5. Almost one-third, 32 per cent, of Oregon State College engineering physics students who studied high school chemistry said it was either of very much or some help in college physics. About 63 per cent thought high school chemistry was of very little help in college physics.
6. Six out of the nine Oregon State College engineering physics students who had not studied physics in high school said they felt themselves at either very great or some disadvantage in college physics.
7. Better than two-thirds, 68 per cent, of the Oregon State College engineering physics students who studied physics in high school said that high school physics was either of very much or some help to them in college physics. Less than a third, 30.4%, said that high school physics was of very little help in college physics.
8. Almost one-half, 48.4%, of the Oregon State College engineering physics students classified high school physics as easy. Forty-four per cent classified high school physics as of average difficulty while only 7.6% thought high school physics was very difficult.
9. Better than one-fourth, 27.3%, of the Oregon State College engineering physics students who studied

physics in high school said their study of high school physics helped them in planning their college course.

10. A little under one-fifth, 18.2%, of the Oregon State College engineering physics students who studied physics in high school said their study of high school physics helped them in deciding upon a vocation.
11. The largest number of the Oregon State College engineering physics students who studied high school physics checked "learning basic principles" as the phase of high school physics which helped them most in college physics.
12. The two comments made with greatest frequency by Oregon State College engineering physics students were, "the high school physics course should demand more work of the students" and "the high school physics course should put more stress on the basic principles".

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to find what relationship, if any, existed between success in college chemistry and physics and the students' high school preparation in these subjects. Statistical and questionnaire methods were used in making the study. The investigation consisted of a follow-up study limited to Corvallis High School graduates and a questionnaire study limited to Oregon State College physical science students.

Summary

Chemistry. The follow-up study of a sample of 118 Corvallis High School students indicated an approximately 30% higher mean grade point average in college chemistry within the sample, in favor of the students who studied high school chemistry. There was no significant difference, less than 3%, in the abilities of the two compared groups as determined by I.Q. and A.C.E. ratings.

The questionnaire study of a sample of 172 Oregon State College first year chemistry students indicated an approximately 20% higher mean grade point average in college chemistry within the sample, in favor of the students who studied high school chemistry. The relative

abilities of the compared groups were not determined in this case. Similar studies in chemistry found a difference in college grades in favor of students with high school chemistry ranging from less than 1% up to 12%.

A coefficient of correlation of .71 between high school and college chemistry grades was obtained for Corvallis High School graduates who studied chemistry at Oregon State College. Foster (15, pp.743-46), in a similar comparison, reported a coefficient of correlation of .63.

Better than three-fourths of the Corvallis High School graduates with high school chemistry who enrolled in college chemistry completed the three terms while a little over one-half of the Corvallis High School graduates without high school chemistry did so. Wakeham (34, p.740) reported similar results.

College chemistry student opinions gave the impression that they considered their high school chemistry of value in college chemistry. Those who did not take high school chemistry felt they were at a disadvantage. About one-fourth of the students said that their high school chemistry aided them in their educational and vocational planning. The three phases of high school chemistry considered most helpful were: learning to write formulas and equations, vocabulary,

and atomic structure. The two comments made with greatest frequency were that problem solving should be emphasized and more practice given in writing chemical equations. Many of them stated that their high school course should have demanded more work.

Physics. The follow-up study of a sample of 55 Corvallis High School students indicated an approximately 4% higher mean grade point average in college physics within the sample in favor of the students who had not studied high school physics. There was no significant difference, less than 5%, in the abilities of the two compared groups as determined by I.Q. and A.C.E. ratings. The questionnaire study of a sample of 75 Oregon State College engineering physics students indicated an approximately 16% higher mean grade point average in engineering physics within the sample in favor of the students who studied high school physics. The relative abilities of the compared groups was not determined in this case. However, since the sample was taken in the winter term, it did not include those who had already failed or withdrawn. Most of the similar studies indicated differences in college physics grade point averages in favor of the students with high school physics. However, most of the investigators classified the differences as insignificant.

A coefficient of correlation of .56 between high school and college physics grades was obtained for Corvallis High School graduates who studied physics at Oregon State College. This value lies between the coefficient of correlation of .74 found by Foster (15, pp.743-46) and .324 obtained by Adams (1, p.50).

It was found that 63% of the Corvallis High School graduates with high school physics who enrolled in college physics completed the three terms while 47% of the graduates without high school physics did so.

College physics student opinions gave the impression that they considered high school physics of some value in college physics. The lack of high school chemistry was considered to be of no great disadvantage in college physics. About one-fourth of the students said that their high school physics helped them in their educational and vocational planning. The phase of high school physics considered most helpful was the learning of basic principles. The comment made with greatest frequency was that the high school physics course should emphasize problem solving and reasoning. A great many of them said that they should have been required to work harder in their high school physics course.

Conclusions

1. Based on the results of this study, high school chemistry seemed to have a significant beneficial effect on success in college chemistry. However, three out of five similar studies called the beneficial effect insignificant.
2. The amount of the influence that high school chemistry had on success in college chemistry was found to be extremely variable. This was probably due to the many possible variations in standards, content, teaching methods, and procedures among high schools and also among colleges.
3. High school chemistry grades for Corvallis High School students showed a slightly higher correlation with grades in college chemistry than did the high school total grade point average. Both coefficients were high enough, .71 and .67, to indicate that in the case of Corvallis High School students, grade point averages in high school chemistry and also the total grade point average in high school would be valuable, when used with other data (I.Q., Aptitude, and Interest Tests) from the student's record, in prediction of success in college chemistry.
4. The opinions of the great majority of college

chemistry students who took high school chemistry indicate that they would recommend chemistry as one of the high school subjects to be taken by students planning further work in that field. Their opinions concerning what should be emphasized are worthy of study by high school teachers. From the number who said they were helped in their educational and vocational planning it could be inferred that high school chemistry does have significance from a student guidance viewpoint. The majority opinion was that more work should be required of the high school science student.

5. The effect of the study of high school physics on success in college physics was much less apparent in this study than was the effect of high school chemistry on success in college chemistry. However, high school physics seemed to show some effect in terms of the higher percentage of students who completed one year of college physics. This study and similar ones indicated a poorer articulation between high school and college physics than was found between high school and college chemistry. The writer believes that two possible explanations for the poor articulation between high school and college physics which were given by Adams (1, pp.51-52) are

reasonable. As one explanation he mentioned that while most high school physics texts abound with practical applications, many college texts use a more abstract presentation. A wide difference in teaching methods at the two levels was given as his second explanation.

Perhaps the poorer articulation between high school and college physics compared with that between high school and college chemistry is due somewhat, at least, to certain characteristic differences between the two science fields. The extreme breadth of the field of physics has produced texts which are organized with a greater variety of subject matter than is found in any other science field. By contrast, chemistry has a greater unity of subject matter with a much narrower range of fundamental concepts, principles and mathematical relationships. A smaller number of fundamental principles and facts are used again and again throughout the chemistry course, while in physics, the student cannot spend sufficient time on any one phase to become even partially accustomed to its terminology.

6. The opinions of college physics students were not so positive in regard to the value of high school physics as were the opinions of college chemistry students on the value of high school chemistry. From the number who said they were helped in their educational and vocational planning, it could be inferred that high school physics and chemistry have about the same significance as an aid to student guidance.
7. The great number of drop-outs and failures in both first year college chemistry and physics indicates the need for more and better guidance for high school students in their vocational and educational planning. In the 1952 fall term at Oregon State College, 105 out of 550 first year chemistry students and 43 out of 268 first year physics students withdrew or failed.
8. The differences in success in college chemistry and physics favoring the students with high school training in the same subjects is not of sufficient significance to warrant the teaching of these subjects in high school on a solely college preparatory basis.
9. Only a minority of high school science students continue further study in college science. For example, in this study only about one-fourth of the 450 high school graduates traced at Oregon State College enrolled in college chemistry while only 12%

of them enrolled in college physics.

10. The fulfillment of the objectives of science for general education should, at the same time, provide the best type of preparation for college science.

Recommendations

1. High school and college teachers should work together in revaluating course content, methods, and materials used in teaching chemistry and physics. Special consideration should be given to the reorganization of physics courses so that the quantity of material to be covered in the course will be commensurate with the time available. The organization of physics texts, the nature of the material to be included and omitted should be re-examined cooperatively by high school and college physics teachers.
2. All high school teachers and advisors should be made more aware of the fact that enrollment in science courses can help students to discover their interests and capabilities in science and related fields. It has long been the conviction of the writer that the better students should all be encouraged to enroll in at least one physical science course.
3. A comprehensive study of student failures in college science might well be made to determine the most

common causes of failures. The great number of withdrawals and failures in first year college chemistry and physics courses indicates that more guidance of high school students is needed from the standpoint of discouraging those who would, from all indications, do poorly in college science or engineering.

4. High school science courses should demand more work and a higher quality of work from the student. This majority opinion of college science students who studied high school science should be brought to the attention of present and future high school science students and teachers.
5. The objectives of science for general education should remain as the major teaching objectives of science.
6. Schools should feel free to experiment with new courses of study in science and they should not be afraid to make appropriate changes in the science curriculum that seem to be indicated as advisable by the outcomes of the experiments.

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APPENDIX A

Questionnaire For First Year
College Chemistry Students

This questionnaire has two objectives: (1) To determine the value, if any, of high school science to the college student of science; (2) to gather data that might make possible the improvement of high school science courses. The data collected will be treated statistically without reference to individual students or schools.

Name_____Class: (Freshman__)(Soph.__)(Other__).

Graduated from _____High School in 19____.

Major School in college_____Major Department_____
College chemistry course (check one).(101__)(104__)(201__)(204__).

What vocation do you plan to follow?_____

1. Did you take high school chemistry?____; average grade in H.S.Chem._____
2. Did you take high school physics?_____; average grade in H.S.Physics____
3. Check the mathematics courses which you had in high school. (__Gen.Math.) (__Algebra)(__Advanced Algebra)(__Geometry)(__Trigonometry).

4. First term grade in General Chemistry in college_____.
5. Check the phrase which best describes how you would classify first year college chemistry as to difficulty. (__very difficult)(__of average difficulty)(__easy).

6. If you did not take physics in high school, to what degree do you feel that you were at a disadvantage in first year college chemistry as a result of not having had high school physics?
(__very much)(__some)(__very little)(__uncertain).
7. If you did take high school physics, to what degree did it help you in college chemistry? (__very much)(__some)(__very little)(__uncertain).

8. If you did not take chemistry in high school, to what degree do you feel that you were at a disadvantage in first year college chemistry as a result of not having had high s chool chemistry?
(__very little)(__very much)(__some)(__uncertain).

9. If you did take high school chemistry,
   (a) how much did it help you in college chemistry? (__very much) (__some)(__very little)(__uncertain).
   (b) how would you classify high school chemistry as to difficulty? (__very difficult)(__of average difficulty)(__easy).
   (c) did it help you in planning your college course? (__yes)(__no) (__uncertain).
   (d) did it help you in deciding upon a vocation? (__yes)(__no) (__uncertain).
   (e) which of the following phases of high school chemistry helped you most? (check no more than three). (__vocabulary)(__writing formulas and equations)(__problem solving)(__atomic structure) (__use of periodic chart)(__laboratory work)(__teacher demonstrations)(__learning about uses of chemistry in life).
   (f) (Optional) what would you suggest that might be done by the high school teacher to improve the high school course in chemistry? (use other side of sheet if more space is needed)

_____

_____

APPENDIX B

Questionnaire For First Year
College Physics Students

This questionnaire has two objectives: (1) To determine the value, if any, of high school science to the college student of science; (2) To gather data that might make possible the improvement of high school science courses. The data collected will be treated statistically without reference to individual students or schools.

Name_____Class, (Freshman__)(Soph.__)(Other__).

Graduated from _____High School in 19____.

Major School in college_____Major Department_____

What vocation do you plan to follow?_____

1. Did you take high school physics?_____; average grade in H.S.Physics____
2. Did you take high school chemistry?____; average grade in H.S.Chem._____
3. Check the mathematics courses which you had in high school. (__Gen.Math.) (__Algebra)(__Advanced Algebra)(__Geometry)(__Trigonometry).
4. First term grade in General Physics in college_____.
5. Check the phrase which best describes how you would classify first year college physics as to difficulty. (__very difficult)(__of average difficulty)(__easy).
6. If you did not take chemistry in high school, to what degree do you feel that you were at a disadvantage in first year college physics as a result of not having had high school chemistry? (__very much)(__some) (__very little)(__uncertain).
7. If you did take high school chemistry, to what degree did it help you in college physics? (__very much)(__some)(__very little)(__uncertain).
8. If you did not take physics in high school, to what degree do you feel that you were at a disadvantage in first year college physics as a result of not having had high school physics? (__very much) (__some)(__very little)(__uncertain).
9. If you did take high school physics,
   (a) how much did it help you in college physics? (__very much) (__some)(__very little)(__uncertain).
   (b) how would you classify high school physics as to difficulty? (__very difficult)(__of average difficulty)(__easy).
   (c) did it help you in planning your college course? (__yes)(__no) (__uncertain).
   (d) did it help you in planning or deciding on a vocation? (__yes) (__no)(__uncertain).
   (e) which of the following phases of high school physics helped you most? (check no more than two). (__learning vocabulary) (__problem solving)(__laboratory work)(__teacher demonstrations) (__learning basic principles)(__learning about applications of physics).
   (f) (Optional) what would you suggest that might be done by the high school teacher to improve the high school course in physics? (use other side of sheet if more space is needed)

_____

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