AN INVESTIGATION OF METHODS FOR VITALIZING HIGH SCHOOL CHEMISTRY AND PHYSICS COURSES

A Thesis

Presented to

the Faculty of the College of Education

The University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Advanced Master of Education

by

Jeanne Levy Gelber

August 1954

PREFACE

I wish to express my sincere appreciation to Dr. William J. Yost for his advice and untiring assistance during the progress of this investigation. Thanks are also expressed to the other members of the committee, Dr. June Hyer and Dr. W. H. Strevell. Invaluable aid was given by Edith S. Hodges and Mary E. Bartlett, who criticized the manuscript constructively.

The investigator is indebted to R. B. Sparks, Baytown; Joseph W. Griggs, Huntsville; V. W. Miller, Pasadena; D. E. Bailey, Beaumont; Clyde Prestwood, Navasota; Terrell Ogg, Freeport; Leslie Richardson, College Station; and John M. Moorman, Hempstead; for making available the data upon which this field study is based. And, finally, acknowledgement is made to the many students, ex-students, and science teachers without whose cooperation this thesis could never have been written.

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Abstract

Statement of the Problem. The purpose of this field study was (1) to find out if the trend of decrease in per cent of enrollment in chemistry and physics over the United States existed in this area of Texas, and (2) to find out what activities were practiced in those schools which have succeeded in attracting large numbers of students into their physical science courses.

Methods of Procedure. The procedure followed in this investigation was critical analysis of the research literature on what has been happening in science teaching. The participating schools were selected and their principals interviewed to secure permission for their cooperation in this study. Questionnaires were mailed. The data obtained from the questionnaires were compiled, studied, and analysed. Activities used in successful science courses were determined. The material was interpreted by tabulation and graphic representation to disclose the true meaning and significance of the data.

Major Findings. 1. The chemistry enrollment of 9.14 per cent in the participating schools was 20.26 per cent higher than the national matriculation of 7.60 per cent and only 0.96 per cent below the peak enrollment of 1890. The

physics enrollment of 4.25 per cent was 1.16 per cent under the national average of 4.30 per cent. In no school was there over 10 per cent of non-college preparatory students present in a physical science class; the average for all schools was 3.25 per cent.

2. The small agricultural schools had the largest per cent enrollment in chemistry and physics. The next largest enrollment was found in college dominated areas, and the smallest in percentage of enrollment was in schools located in industrial areas.

3. The consensus was that "all American youth" need a scientific background.

4. Pupils enjoyed much of what they saw, for demonstrations, field trips, and other visual aids were high on the list of vitalizing activities.

5. Through student approval of talks made by visiting scientists, chemistry and physics were made to come alive. Rapport was established between the community and the classroom.

6. Learners liked teachers' lectures when they contained clear explanations.

7. Boys and girls delighted in both individual work, and work with others where they themselves had opportunity for participating in the activities.

8. A poor science teacher could not arouse the interest

of the teen-ager. Pupils confused the dislike for a particular teacher and his methods with dislike for the course. Hence, poorly trained elementary and junior high school science teachers deterred students from a continued study of science. In the questionnaires, boys and girls constantly reiterated they liked "a good science teacher" and they disliked "a poor science teacher". Undoubtedly the teacher was a big factor in the size of the enrollment. Students wanted an enthusiastic, sympathetic person, well-trained in the fundamentals of science and in methods of teaching.

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CHAPTER I

THE PROBLEM OF VITALIZING HIGH SCHOOL CHEMISTRY AND PHYSICS COURSES

I. STATEMENT OF THE PROBLEM

The purpose of this investigation was (1) to find out if the trend of the decrease in the percentage enrollment of chemistry and physics students over the United States existed in this area of Texas, and (2) to find out what activities were practiced in those schools which have succeeded in attracting large numbers of students into their physical science courses.

II. NEED FOR THE PROBLEM

Many articles have appeared in current periodicals stressing the need for more people trained in science because of the increasing importance of technology and because of the realization by the industrialist of the value of research. The high school through its chemistry and physics courses is one of the primary sources of science information which is preliminary to training for job opportunities and further studies.

The percentage of enrollment in physics[1] has shown a steady drop from 22.21 per cent in 1890 to 4.30 per cent in 1952. At the same time the chemistry enrollment has dropped from 10.10 per cent in 1890 to 7.60 per cent in 1952. However, following World Wars I and II, there were slight gains in the percentage of enrollment in chemistry.

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[1]George Greisen Mallinson, Walter G. Marburger, Davie J. Miller, Gerald Osburn, and David Worth, "Final Report to the Central Association of Science and Mathematics Teachers of Its Committee on the Significance of Mathematics and Science in Education," School Science and Mathematics, 54:119, February, 1954.

In the face of the aforementioned decrease[2] in the study of science there has been an unprecedented increase in

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[2]Alfred Kahler and Ernest Hamburger, Education for an Industrial Age (New York: Cornell University Press, 1948), Pp. 24-52.

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the need for people with science training. The increasing importance of technology affords greater opportunities for better trained people. Industry has seen the value of research in solving the problems of the manufacturer,[3] the

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[3]Carol A. Hochwalt, "The Impact of Chemistry on the World of Science," The Scientific Monthly, 77:48:53, July, 1953.

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government has taken many trained scientists into the armed forces and into federal technical service, and knowledge of science is necessary for an understanding of the world around us. In a democracy all citizens must have a science education in order to understand and intelligently use the products of science.

> From executive to cleaning crews, everybody is benefitted by knowing more about the materials handled and the products manufactured. Is there anybody who would not be helped by a course in chemistry?[4]

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[4]__________, "Who Needs Chemistry?" Chemistry, 27:1, September, 1953.

The high school science curriculum must prepare every child with the knowledge necessary to live wisely in our scientific age and must at the same time interest enough youth in science as a vocation to give our country a sufficient supply of professional scientists. Although in June, 1953, industry needed 32,000 college trained engineers,[5] all of the colleges

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[5]Karl Schriftgiesser, "The Engineer -- They Have No Fears," Colliers, 132:65, October 2, 1953.

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in the United States graduated only 22,500 scientifically trained men and women -- and of these, 10,000 men faced the draft. In this connection it may be well to note that Russia has been educating 30,000 well trained engineers annually. Because the demand for scientifically trained people is greater than the supply,[6] high school teachers should do all

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[6]Dael Wolfe, "Future Supply of Science and Mathematics Students," The Science Teacher, 20:157-160, September, 1953.

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they can to interest bright youngsters in science as a vocation. Persistent work by high school chemistry and physics teachers can help insure the United States a sufficient supply of trained people.

III. LIMITATIONS OF THE STUDY

In order to determine whether or not there has been a decrease in the percentage of enrollment in chemistry and physics classes, a survey was made in eight South Texas areas predominated (1) by industry, (2) by agriculture, and (3) by a college atmosphere. Schools A, B, and C were chosen because they were situated in the centers of vast chemical industries. Schools F, G, and H were chosen as representative of areas predominated by a college atmosphere. Schools D and E represented districts primarily agricultural in nature. The study was limited to (1) juniors and seniors enrolled in chemistry and/or physics for the school year 1953-54, (2) to an equal number of juniors and seniors not enrolled in either of these two courses, (3) to the science teachers under whom these people were studying, (4) one hundred fifty scientifically selected ex-students of one of the schools, and (5) to the principals of the participating schools.

IV. PROCEDURES AND TECHNIQUES

The procedure followed in this investigation was critical analysis of the research literature on what has been happening in science teaching. Letters were sent to the National Education Association; the National Science Teachers

Association; the Office of Education, Federal Security Agency, United States Government; and Dr. Frederick Eby to ask aid in finding material on the history of the teaching of chemistry and physics. Not one of these agencies or individuals knew of any available material.

The participating schools were selected and their principals interviewed to secure permission for their cooperation in this study. Questionnaires were mailed. The data obtained from the questionnaires were compiled, studied, and analyzed. Similarities and dissimilarities were noted. Activities used in successful science courses were determined. The efforts of the teachers to acquaint their students with the possibilities in the field of science were examined. The material was interpreted by tabulation and graphic representation to disclose the true meaning and significance of the data. On the basis of the conclusions drawn, recommendations were made.

V. SUMMARY

Chapter I includes the introduction, a statement of the problem, the need for the problem, the limitations of the problem, the procedures, and techniques followed, and the summary. Chapter II gives a background for the problem and a survey of previous investigations made in this field. In Chapter III the data obtained from the questionnaires were compiled, studied, and analyzed. Chapter IV contains a general summary, conclusions, and recommendation for further research needed.

CHAPTER II

HISTORICAL REVIEW

In the introductory portion of this study, the present need for vitalizing high school chemistry and physics courses was discussed. Historically science education in the American schools can be divided into three periods.[7] The early period

[7] Carleton E. Preston, The High School Science Teacher and His Work (New York and London: McGraw -- Hill Book Company, 1936), Pp. 20-48.

dated from 1750 until about 1870; the middle period, characterized by college domination, lasted until 1905; and the recent period in which the secondary schools have gradually established themselves as institutions for the masses is still continuing.[8]

[8] Ellwood D. Heiss, Ellsworth S. Osborn, and Charles W. Hoffman, Modern Science Teaching (New York: The MacMillan Company, 1951), Pp. 3-19.

I. THE EARLY PERIOD

Although natural philosophy and astronomy were taught in some schools which preceded the academy movement, science instruction had its real beginning in the Philadelphia Academy[9] founded by Benjamin Franklin in 1751. Franklin's conception of education was much like that of today's educator.

He expressed the belief that young people who intended to become merchants should study nature that they might better

[9] V. T. Thayer, Chairman, Commissioner on Secondary School Curriculum, Science in General Education (New York, London: D. Appleton -- Century Company, 1931), p. 5.

understand the commodities they sold, by craftsmen that they might learn to use new material, by ministers that they might better understand the proofs of the evidence of God, and by all that they might become better conversationalists. He antedated the laboratory method in that he suggested science be accompanied by actual practice in gardening. He said the Academy was established

> for instructing youth not only in English, but Latin grammar, writing, arithmetic, and those sciences wherein they are commonly taught, but more especially to learn them the great and real business of life.[10]

[10] George W. Hunter, Science Teaching (New York, Cincinnati, Chicago, Boston, Atlanta: American Book Company, 1934), p. 18.

Natural philosophy, a forerunner of physics, attempted to acquaint young people with an understanding of common phenomena which would give them a greater command of their environment.[11] Four Academies[12] taught chemistry prior to

[11] Carleton E. Preston, The High School Science Teacher and His Work (New York and London: McGraw -- Hill Book Company, 1936), Pp. 21-23.

[12] Ibid., p. 24.

1820, and fifteen more added it to their curriculum within the next ten years. Any science taught was unsystematized and fragmentary. The aims were descriptive, utilitarian, and religious. Some of the early textbooks were in the form of catechisms. Value was placed on the ability to describe natural phenomena as an end in itself. Instruction was basically organized to facilitate the presentation of factual material in the form of lectures and textbook assignments with a later recitation. There was little regard toward developing relationships or logical thinking.

The first free public high school[13] in the United States

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[13] A. A. Douglass, "The Junior High School," Fifteenth Yearbook of the National Society for the Study of Education, Part III. Chicago: University of Chicago Press, 1916, Pp.

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was the English High School established in Boston in 1821. Natural philosophy, natural history, and chemistry were in the curriculum. Natural philosophy which included physics, astronomy, and earth science started as an environmental subject. In 1823 courses of experimental lectures[14] in natural philosophy began to appear. Four years later schools

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[14] Preston, op. cit. p. 26.

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initiated the practice of buying apparatus. But, science courses remained mainly book courses and little actual laboratory work was done. The first record of the construction of a high school laboratory[15] was in St. Louis in 1845, but

[15]*Ibid.*, p. 26.

ten or eleven years passed before it was in use by the pupils. In 1857, Massachusetts passed a law requiring public high schools to give courses in natural philosophy. In 1860, five per cent of the high schools offered courses in physics.

In the early science courses emphasis was on memorizing factual material. Most of the teaching was done by the lecture and recitation method. Prior to 1860 there was little or no laboratory work.

> Some acquaintance with the subject (chemistry) is now required as a part of every good education; but books designed for laboratory use and abounding in technical details are ill suited to those who do not give special and thorough attention to the subject.[16]

[16]E. L. Youmens, *Class-Book of Chemistry* (New York: D. Appleton and Company, 1875), p. 5.

Authors of early textbooks usually introduced each topic with a problem which was not explained, and concluded with the statement of a principle. The nineteenth century saw substantial shifts in the character and aims of the secondary school.[17] The changing pattern in society caused an increase

[17]Freeman R. Butts, *A Cultural History of Education* (New York and London: McGraw -- Hill Book Company, Inc., 1947), p. 506.

in science enrollment.

II. THE MIDDLE PERIOD

Natural philosophy remained in the curriculum until 1872. The great advance made in the physical sciences in the latter part of the nineteenth century gave a further impetus to the teaching of physics.

> Such are already the vast proportions of the sciences, and such are the enormous rapidity of its growth, that nothing less than works of encyclopediac scope have value for general consultation.[18]

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[18]Youmans, _op. cit._, p. 6.

In 1885, twenty-five percent of the high schools offered courses in physics, while twelve years later the percentage had increased to eighty-seven. Physics was made into a logically organized body of subject matter to prove that the disciplinary values were equal or superior to those of the classics.

A rise in the interest in chemistry paralleled an increase in the knowledge of inorganic and organic substances. The textbooks were largely expository and included a series of brief and concise statements of facts paragraphed in logical sequence. At the bottom of the pages were often found questions in small type which served as guides to the students, and were used by the teacher in direct questioning. There were few illustrations.

The growth of the laboratory movement was gradual and as late as 1880 the United States Bureau of Education reported only four high schools giving a full year course in physics with laboratory work. By 1895, laboratory experimentation had been generally adopted.

When Harvard announced in 1872 that high school science courses were acceptable for college entrance credit, other colleges followed this lead. In 1887, the Harvard Descriptive List was published. This listing reported forty-six experiments which were acceptable for college entrance material. The high school texts became simplified and condensed college books. Because of the college influence science was lifted to a position of greater importance, and the schools in attempting to meet requirements brought about a high degree of standardization. During this period it was believed there was virtue in the disciplinary value of difficult subjects. Science, therefore, offered a unique opportunity by training the faculty of observation and the concentration of thought. The use of science for formal discipline led to the introduction of too much mathematics and the neglect of its more practical phases. Much stress was laid on accuracy, self-reliance, and logical thinking, and the memorizing of specific facts. As physics gained in organization it became formal, with the pupil being ignored and resulting in a book-centered, highly abstract, college preparatory course.

With the acceptance of chemistry for college entrance, standards began to be set up. This meant the setting up of laboratories and the beginning of real experimental procedures. By 1885 any high school that offered chemistry made some provision for this type of work. College domination made memorization of factual material the chief aim of the student, and deadened initiative by requiring a certain number of exercises, all of which had to be submitted as evidence of having satisfactorily completed the college requirements. Teaching was carried on with little or no regard for the particular interests or needs of the learner.

III. RECENT PERIOD

The third period represented a reaction against the disciplinary aim and against college preparation as the chief functions of science teaching. The first published report on a research investigation[19] of science teaching, in Passaic, New Jersey, appeared in 1904. From 1910 until 1920 investigations on the teaching of science materialized in slowly increasing numbers. Following 1912 many studies were devoted to the relative value of the individual laboratory method and demonstration.[20] Since most of the early studies measured gains in factual information only, the researchers concluded

[19] Francis D. Curtis, "Milestones of Research in Teaching of Science," Journal of Educational Research, 44:161-178, November, 1950.

that the demonstration was superior to individual work, especially in view of the economy in time and money.

[20] Ralph E. Horton, "Measureable Outcomes of Individual Labwork in High School Chemistry," Science Education, 14:311-319, November, 1929.

The reports[21] of the commission on the Reorganization

[21] Clarence D. Kingsley, chairman, "Cardinal Principles of Secondary Education," A Report of the Commission on the Reorganization of Secondary Education of National Education Society, 1918, Bulletin #35 (Washington, D.C.: United States Bureau of Education) 32 pp.

of Secondary Education of the N.E.A. in 1918 started the trend toward a change in having the high school meet more adequately the newer demands of a functional approach in instruction. This report was an attempt to lead away from the narrow factual disciplinary emphasis to the broad requirements of the learner. A report by the commission[22] of the Reorganization of Secondary

[22] Otis W. Caldwell, Chairman Committee on Science, "Report of Subcommittee on Teaching Science," Bulletin #26 (Washington, D.C.: United States Bureau of Education) 62 pp.

Education was the first comprehensive document to deal exclusively with the teaching of science in secondary schools. This report endeavored to show how science instruction could contribute to the cardinal principles of secondary education, and at the same time give practical help on the selection and organization of materials, and on the teaching of science in the high school. This report pointed science instruction toward larger social goals than previously had been set. In 1927, a committee of the American Association for the Advancement of Science issued a report[23] which emphasized the

[23]AAAS, "Committee Report on the Place of Science in Education," School Science and Mathematics, 28:640-664, June, 1928.

importance of thinking as an objective of science teaching and recommended that studies on a national scope be set up on that subject. "A Program for Teaching Science" published in 1932 by the National Society for the Study of Education set up "life enrichment through participation in a democratic social order" as the aim of education rather than the teaching of laws and theories of pure science. The Forty-Sixth yearbook[24] entitled "Science Education in American Schools" stresses the

[24]Nelson B. Henry, "Science Education in the American Schools," Forty-Sixth Yearbook of the National Society for the Study of Education, Part I. Chicago: University of Chicago Press, 1947, Pp. 137-151.

importance of science taught for its functional value in aiding the adjustment of individuals to the changing world and in the solving of problems at their maturity levels.

IV. SUMMARY

During the first two hundred years of educational history in America three types of secondary schools came into existence. There is no record that science formed a part of the curriculum of the Latin Grammar School, for its purpose was to prepare students for the ministry. The academies catered to the interests of those not going to college and set up courses suited to the needs of the community. In 1854, 26.6 per cent of all high school students in Ohio were enrolled in chemistry.[25] The early period took no account of

[25]Ellwood D. Heiss, Ellsworth S. Osburn, and Charles W. Hoffman, Modern Science Teaching (New York: The MacMillan Company, 1951), p. 5.

the development of logical thinking stressed during the later period. Science teaching was simply informative and based on the storage of facts. Education was reserved for the children of the well-to-do.

Ten years before the turn of the century, 250,000 pupils were enrolled in the last four years of high school,[26]

[26]Philip G. Johnson, "Occurrences of Science Courses in American High Schools," The Bulletin of the National Association of Secondary-School Principals, (Washington, D.C.: National Association of Public School Principals, 1953), p. 25.

and of these 156,726 or 62 per cent went to college.[27] In 1910 only ten per cent of the nation's fourteen to seventeen

[27]Statistical Abstracts of the United States.

year olds were in school, with 75 per cent of them going on to college, while in 1946 between 70 and 75 per cent of this age group were in high school[28] with only 25 per cent seeking college education. With the change in the high school popu-

[28]Harl R. Douglass, Secondary Education for Life Adjustment of American Youth (New York: The Ronald Press Company, 1952), p. 22.

lation from the traditionally aristocratic and exclusive to one from the masses, school curricula have had to keep pace by presenting an opportunity for all American youth. It has been widely accepted that in addition to knowledge of subject matter, the teacher had to know how to organize and present it. The tendency has seemed to be to require less drawing, fewer experimental writeups and less filling in of laboratory manuals. The concept that principles, their understanding and interpretation, were of more value than fact mastery has been widely accepted.[29] Physics has departed less from the

[29]Ibid., Pp. 37-57.

old traditional standards than has chemistry. Modern chemistry texts have been written by people who understand pupils as well as subject matter.

Science and technology have created the possibility of endless progress toward more secure and pleasant living. Science teaching has equipped boys and girls to successfully grapple modern problems. The general belief[30] is that science education should be presented to (1) develop skills in reflective thinking and problem solving, and (2) to stimulate, guide,

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[30] Francis D. Curtis, "Basic Principles of Science Teaching," The Science Teacher, 20:55-59, March, 1953.

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and develop scientific interests, attitudes, and appreciations. Dr. S. S. Schaffer,[31] Public Relations Manager, Humble Oil and Refining Company, Baytown, Texas, in a talk to the Baytown Science Teachers, said, "The object of science teaching today

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[31] S. S. Schaffer, "Science Training, Today's Need," Talk presented to science teachers, Goose Creek Independent School District, November 6, 1953.

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is to train youth to think in terms of facts, to keep his mind open, and to use the scientific method in all things."

CHAPTER III

THE FINDINGS

I. METHOD OF PROCEDURE

This investigation was undertaken in order to determine whether the trend of a decrease in the national enrollment in chemistry and physics appeared in the southeast portion of Texas. As shown in Table I, eight schools, three in industrial areas, two in agricultural regions, and three in sections dominated by the influence of colleges, were chosen for this field study. In August, 1953, principals of the selected schools were interviewed to secure permission for the participation of their institutions in this study. Questionnaires were developed and sent out. These forms, filled in without supervision and unsigned, were returned by eight principals, twelve science teachers, 566 students enrolled in chemistry and/or physics, 185 boys and girls not registered for either chemistry or physics, and 116 ex-students of one of the participating schools. Table II shows the response to these questionnaires. All information has been compiled and analyzed. Tables and their accompanying explanations were designed to reflect (1) those activities the students found stimulating, and (2) those activities former students, teachers of science, and administrative personnel believed are interesting and worthwhile.

TABLE I

TYPE OF COMMUNITY OF PARTICIPATING SCHOOLS

School	Type of Community
A	Industrial
B	Industrial
C	Industrial
D	Agricultural
E	Agricultural
F	College
G	College
H	College

TABLE II

RESPONSE TO QUESTIONNAIRES

School	Questionnaires	Number of Cases Mailed	Number of Cases Returned
A	Principal	1	1
	Science Teachers	2	2
	Ex-students	150	116
	Students enrolled in chemistry and/or physics	159	159
	Students not enrolled in chemistry and/or physics	80	80
B	Principal	1	1
	Science Teachers	3	2
	Students enrolled in chemistry and/or physics	150	91
	Students not enrolled in chemistry and/or physics	150	0
C	Principal	1	1
	Science Teachers	2	2
	Students enrolled in chemistry and/or physics	150	132
	Students not enrolled in chemistry and/or physics	150	59
D	Principal	1	1
	Science Teachers	1	1
	Students enrolled in chemistry and/or physics	30	24
	Students not enrolled in chemistry and/or physics	30	27
E	Principal	1	1
	Science Teachers	1	1
	Students enrolled in chemistry and/or physics	30	8
	Students not enrolled in chemistry and/or physics	30	2

TABLE II (continued)

RESPONSE TO QUESTIONNAIRES

School	Questionnaires	Number of Cases Mailed	Number of Cases Returned
F	Principal	1	1
	Science Teachers	2	1
	Students enrolled in chemistry and/or physics	50	17
	Students not enrolled in chemistry and/or physics	50	0
G	Principal	1	1
	Science Teachers	1	1
	Students enrolled in chemistry and/or physics	50	14
	Students not enrolled in chemistry and/or physics	50	19
H	Principal	1	1
	Science Teachers	3	2
	Students enrolled in chemistry and/or physics	150	121
	Students not enrolled in chemistry and/or physics	150	0
Totals	Principals	9	9
	Science Teachers	13	12
	Students enrolled in chemistry and/or physics	769	566
	Students not enrolled in chemistry and/or physics	690	185

II. DATA OBTAINED

The total enrollment of the last three grades of the participating schools varied from 1,388 down to sixty. The total registration by schools together with their chemistry and physics enrollment for the year 1953-54 is shown in Table III. Schools A, B, C, and H scheduled both chemistry and physics courses every year. Schools D, F, and G alternated these courses with D and F having offered physics in odd numbered years, while in G, it has been given in even numbered years. School G indicated the enrollment in chemistry and physics has been about the same. School E has scheduled chemistry annually but has not listed physics among its offerings.

Information from principals. Table IV shows the percentage of the total student body who planned to go to college, while column three indicates that chemistry and physics classes were composed almost entirely of pupils who intend to continue their education beyond high school. Only one school indicated as high as ten per cent of the students in these courses did not propose to enter college, and this school, G, was in an area dominated by the college influence.

Many students listed fear of failure as a reason for not signing up for chemistry and/or physics, but as shown in Table V, only one of the eight schools studied had a higher

TABLE III

ENROLLMENTS BY SCHOOLS

School	Enrollment grades ten through twelve	Chemistry		Physics	
		number	per cent	number	per cent
A	1,388	148	10.66	32	2.31
B	768	64	8.33	36	4.69
C	1,237	93	7.51	32	2.59
D	170	---	---	20	11.11
E	60	9	15.00	---	---
F	300	---	---	17	5.66
G	124	26	20.97	---	---
H	1,150	135	11.74	84	7.34
Totals	5,197	475	9.14	221	4.25

TABLE IV

PERCENTAGE OF GRADUATES GOING TO COLLEGE
PERCENTAGE OF CHEMISTRY AND PHYSICS STUDENTS
WHO ARE ENROLLED IN A COLLEGE PREPARATORY COURSE

School	Per cent of graduates going to college	Per cent of class who are college preparatory students
A	55.00	98.00
B	39.00	99.00
C	32.00	99.00
D	40.00	95.00
E	60.00	100.00
F	---	95.00
G	95.00	90.00
H	---	98.00
Totals	53.50	96.75

TABLE V

PERCENTAGE OF FAILURES

School	Per cent of failures		
	Chemistry	Physics	Entire school
A	2.00	10.00	3.00
B	---	---	---
C	12.00	14.00	9.00
D	1.00	1.00	10.00
E	---	---	2.00
F	---	---	---
G	1.00	0.50	1.00
H	3.00	4.00	7.00
Average for all schools	3.80	5.90	4.00

percentage of failure in the physical sciences than in the school as a whole. Two schools reported a markedly lower percentage of failure in these courses than in all others. One school recorded a low percentage of failure in chemistry, but a ten per cent failure in physics. In the other instances the percentage of failure in these two science courses was about the same as in other courses. The false belief that it is difficult to pass science courses may have caused students to reject these courses.

Principals feel that science clubs, field trips, guest speakers, assembly programs based on science, and other factors popularize their science courses. Table VI lists techniques found in their schools which tend to make these subjects more inviting. Table VII lists additional techniques, which if practiced, they believe would add to the attractiveness of these courses.

Information from teachers. Teachers of science are convinced that laboratory work is an incentive for boys and girls to register for chemistry and physics. Most instructors suggested that students preferred individual experimentation, while one held that they liked demonstration experiments and lectures. Another teacher of science in a college dominated area believed the students are most interested in adequate college preparation. This information is tabulated in Table VIII. Table IX shows the educators interviewed in this study

TABLE VI

PRINCIPALS' OPINION OF TECHNIQUES IN SCHOOL WHICH POPULARIZE CHEMISTRY AND PHYSICS COURSES

Technique	School A	B	C	D	E	F	G	H
Science Clubs	Yes	Yes	Yes	No	No	---	Yes	No
Field trips	No	Yes	Yes	Yes	No	---	Yes	Yes
Visiting scientists	Yes	Yes	Yes	Yes	No	---	Yes	Yes
Scientific assembly programs	No	Yes	Yes	Yes	No	---	Yes	Yes
Other factors	Local industry	Need for science Interesting laboratory work	Industrial area Teacher Clubs	College entrance requirements	College entrance requirements	---	An enthusiastic teacher, well educated in science and teaching methods	College entrance requirements

TABLE VII

PRINCIPALS' OPINION
HOW CHEMISTRY AND PHYSICS TEACHERS MAY IMPROVE
THEIR COURSES

School	Teaching Technique
A	---
B	---
C	(More field trips (More contacts with local scientists
D	Make chemistry and physics more practical
E	---
F	---
G	Teacher show enthusiasm for what is taught
H	---

TABLE VIII

TEACHERS' OPINION OF WHAT STUDENTS LIKE BEST ABOUT CHEMISTRY AND/OR PHYSICS

Schools	Best Liked
A	Laboratory work
B	Laboratory work
C	Demonstration and lectures
D	Laboratory work
E	---
F	---
G	Valuable college preparation
H	Laboratory work

TABLE IX

TEACHERS' OPINION OF WHAT CHEMISTRY AND/OR PHYSICS STUDENTS LIKE LEAST ABOUT THESE COURSES

Schools	Least Liked
A	Written work
B	Home work
C	Committee work
D	---
E	---
F	---
G	Studying
H	Tests

thought students on the whole disliked work that must be prepared out of class. One teacher found students objected to committee work.

Chemistry and physics teachers believed that many boys and girls do not sign up for these courses because of their reputation as difficult courses. In smaller schools where only one class is listed, the subject changing in alternating years, much difficulty was encountered in scheduling. Even in the larger schools this problem was sometimes evident. Table X contains a tabulation of the information.

Table XI suggests educators considered demonstration experiments, field trips, and opportunity for individual investigation strong motivating forces in increasing chemistry and physics enrollment. Eleven responding teachers did not think these courses should be presented from the college preparatory point of view only; but they indicated a certain amount of mathematics should be included. However, they did not believe this should be a deterrent for those students who have difficulty with mathematics per se, or have inadequate mathematics backgrounds. The majority of the teachers believed their most effective methods were lectures, demonstrations, and experimentation. One teacher thought his most effective technique was a daily quiz. Student responses, however, indicated this device was not popular with them.

TABLE X

TEACHERS' OPINION AS TO
WHY MORE STUDENTS DO NOT ENROLL IN
CHEMISTRY AND PHYSICS

School	Reason
A	Students do not realize need for this knowledge
B	Feel course is too difficult Inability to schedule Home work Fear of subject
C	Reputation as a "hard course"
D	Too technical
E	School too small
F	---
G	Difficulty of subject
H	Inability to schedule Too much mathematics Only the more capable encouraged to enroll

TABLE XI

TEACHERS' OPINION
TECHNIQUES TO INCREASE CHEMISTRY AND PHYSICS ENROLLMENT

Schools	Demonstration experiments	Field trips	Correlated with occupational opportunities in community	Should course be taught only from college point of view	Should chemistry and physics omit mathematics	Should students who have difficulty with mathematics be encouraged to enroll in chemistry	Opportunity for original investigation	Most effective teaching methods
A	Yes	No	Yes	No	No	Yes	No	
B	Yes	---	Partly	Yes	No	No	No	Lecture/demonstration/experimentation/problems
	Yes	Rarely	Yes	No	No	Yes & No	Yes	
C	Yes	Yes	Yes	No	Yes	Yes	Yes	Lecture/demonstration
	Yes	Yes	Yes	Yes	No	Yes	No	Daily quiz
D	Yes	Few	Yes	No	No	Chem. Yes Physics No	No	Laboratory work
E	Yes	Occasionally	---	No	No	Yes	Yes	Knowledge of subject matter/interest in teaching/sympathy/kindness

TABLE XI (continued)

TEACHERS' OPINION
TECHNIQUES TO INCREASE CHEMISTRY AND PHYSICS ENROLLMENT

Schools	Demonstration experiments	Field trips	Correlated with occupational opportunities in community	Should course be taught only from college point of view	Should chemistry and physics omit mathematics	Should students who have difficulty with mathematics be encouraged to enroll in chemistry	Opportunity for original investigation	Most effective teaching methods
F	Yes	Yes	Yes	No	No	?	Yes	---
G	Yes	Yes	Yes	No	No	Yes	Yes	Scientific analysis
H	Yes	No	Yes	No -- segregate students according to need	No	No	No	Lecture/laboratory/home work
	Few	No	No	No	Probably	Yes	No	Experimentation/films/demonstration/explanation

<u>Information from ex-students</u>. Questionnaires were mailed to 150 scientifically selected ex-students of one of the high schools. Of these, 116 were returned. There were seventeen main items with six sub-heads on these forms. Figure 1 shows the range of date of graduation to be from the spring class of 1922 to mid-term, 1954. There was some response from all classes following the year 1930 with the exception of the class of 1939.

Figure 2 and Table XII show the educational background of the responding former students. In regard to place of study the largest number of individuals attended Lee Junior College. In regard to length of study the largest group had one year above high school. Next in number were the twenty-nine who had no college training. Lesser numbers in descending order attended the following senior colleges: Rice Institute, University of Houston, Baylor University, and the University of Texas. The remainder enrolled at various other colleges and universities throughout the United States. Only twenty-five individuals continued their studies until they earned degrees. Among these were ten Bachelor of Science, six Bachelor of Arts, and three Bachelor of Business Administration degrees. As shown in Table XIII, members of the group studied in twenty-five different areas and their occupations ranged through thirty-seven fields, from accountant to welder.

Table XIV shows that eight-five of these adults would

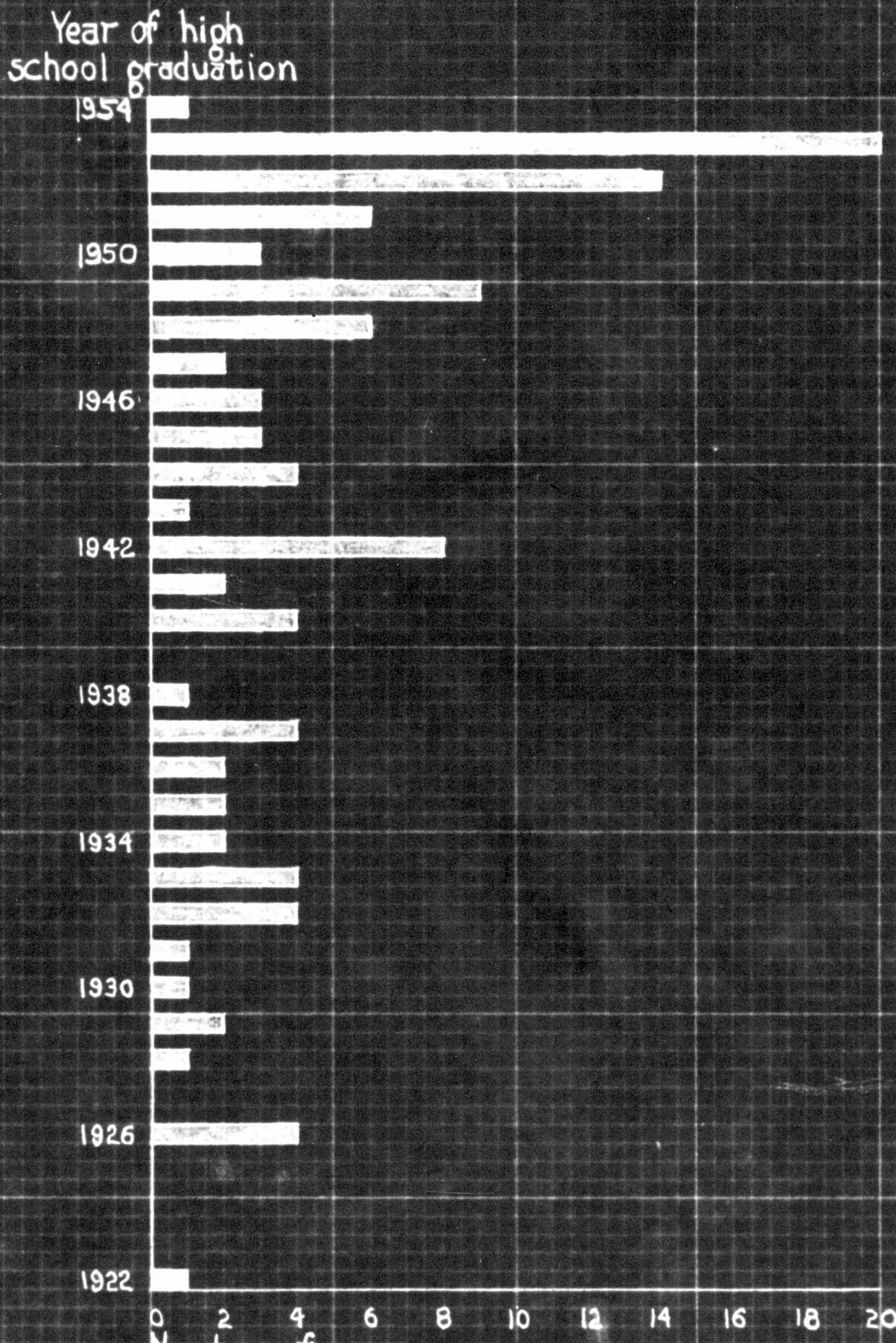

FIGURE 1

GRADUATION YEAR OF EX-STUDENTS

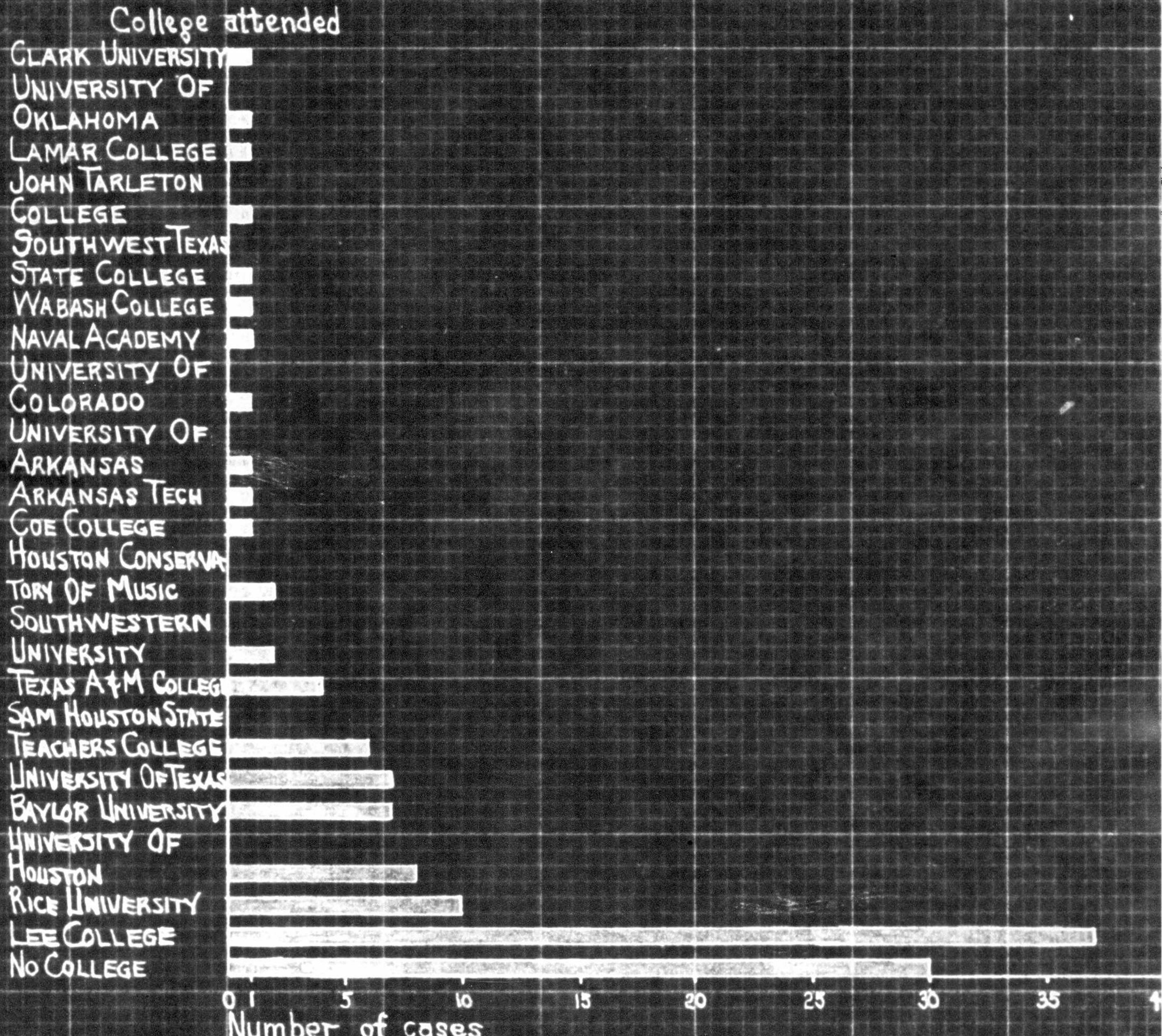

FIGURE 2

COLLEGE ATTENDANCE OF EX-STUDENTS

TABLE XII

COLLEGE STUDY OF EX-STUDENTS

Number of years in college	Number of cases	Degree			
		No	Yes	What degree	Number of cases
0	29	65	25	BS	10
1	33			BA	6
2	25			BBA	3
3	7			DDS	1
4	20			MLT	1
5	4			MS	1
7	1			MA	1
				MM	1
				MD	1

TABLE XIII

COLLEGE STUDY AND OCCUPATION OF EX-STUDENTS

Study	Number of cases	Occupation	Number of cases
Accounting	2	Accountant	2
Agriculture	1	Accounting Clerk	1
Animal Husbandry	1	Armed Service	1
Art	1	Beauty Operatory	1
Biology	1	Chemist	1
Business Administration	13	Choral Director	1
Chemistry	4	Clerk	5
Dentistry	2	Dairy Man	1
Education	10	Dentist	1
Electronics	1	Doctor	1
Engineering	18	Electronic Technician	1
English	4	Engineer	3
History	1	Heavy Equipment Operator	1
Interior Decorating	1	Housewife	22
Liberal Arts	4	Humble Employee	3
Mathematics	2	Insurance Business	1
Medicine	5	Laboratory Assistant	1
Music	3	Laboratory Technician	1
Nursing	1	Laborer	2
Physical Therapy	1	Machinist	2
Physics	1	Medical Technologist	1
Psychology	1	Medicine	1
Religion	1	Merchant	3
Science	1	Navy	3
No College	29	Newspaper Man	1
		None	2
		Preacher	1
		Pressman	1
		Receptionist	1
		Secretary	8
		Sheet Metal Worker	1
		Student	23
		Supervisor	1
		Surveyor	1
		Teacher	7
		Television Technician	1
		Welder	1

TABLE XIV

EX-STUDENTS OPINION AS TO WHETHER OR NOT CHEMISTRY AND PHYSICS SHOULD BE STUDIED IN HIGH SCHOOL

Opinion	Yes	No
Would you have studied chemistry as a high school student if you had known then what you know now of its value?	85	17
Would you have studied physics as a high school student if you had known then what you know now of its value?	70	24

have studied chemistry as a high school student, had they known then of its value; seventeen did not feel that they would have been helped by its study. Seventy would have studied physics as a high school student had they known in high school what they know today; twenty-four thought they would not have been benefited by its study.

Table XV was based on questionnaires answered by sixty-nine past high school students who had studied chemistry in high school. It is a tabulation of their opinions on the value of high school chemistry. Most of these persons expressed the belief that this course helped everybody no matter what his place in life. The greatest number were aware of its value in the preparation for further study, but practical information invaluable in every day living was often suggested. Many considered a study of chemistry fundamental to understanding today's technical society. Others believed it had been helpful in making a choice of their vocations. Still others considered it helpful in securing employment, and in fulfilling their obligations in their occupation. One of the values listed by a number of respondents was the stimulation of latent interest, which in some cases led to the choice of a career in science; in other cases it opened new fields for reading and conversation. Other miscellaneous values have accrued.

Many of the values obtained from the study of chemistry

TABLE XV

OPINIONS OF EX-STUDENTS OF HIGH SCHOOL CHEMISTRY ON THE VALUE OF HIGH SCHOOL CHEMISTRY

Reasons ex-students who studied high school chemistry advise high school students of today to study chemistry	Number of cases
Preparation for further study	58
Practical information invaluable in everyday life	45
Fundamental to understanding today's technical society	19
Helped in occupation	13
Increased occupational opportunities	11
Stimulated interest in chemistry as a profession	9
Vocational guidance	7
Taught to organize and study	6
Interesting course	6
Stimulated latent interests	6
Developed self-confidence and stimulated initiative	5
Informative	4
Household duties	4
Practice in logical thinking and reasoning	4
Reading newspapers and periodicals	3
Conversation	3
Taught to work with hands and mind simultaneously	2
Cooperation with others	2
Credit for graduation	1
No help	1
Developed use of common sense	1
Helped in answering children's questions	1
Handling explosives in armed service	1
Helped in study of English	1
Aroused desire for learning	1
Initiated thinking in scientific terms	1

also resulted from the study of physics as shown in Table XVI. This table is based on the questionnaires answered by thirty-four ex-students who had studied high school physics. The values most frequently mentioned were prerequisite for college study, and knowledge of fundamentals for understanding today's technical society. Next most often cited were exercise in reasoning and vocational guidance. Three persons said that enjoyment engendered from taking the course was reason enough for enrolling in it. One replied that competence in high school physics raised his self-confidence sufficiently that he felt he could do satisfactory work in college.

On the other hand a student who attended a junior college found the college course a repetition of the high school course; hence he made the statement that the high school course was a waste of time unless college physics were made more advanced. A few held that other courses should be chosen in preference unless the students already had a definite interest in science.

Suggested improvements for the teaching of high school chemistry were the increased use of problem solving and additional laboratory exercises. All who entered Rice Institute felt a greater scope of material should be covered and more advanced subject matter should be studied. Those who entered such schools as Texas University, Texas Agricultural and Mechanical College, University of Houston, and the Teachers

TABLE XVI

OPINIONS OF EX-STUDENTS OF HIGH SCHOOL PHYSICS ON THE VALUE OF HIGH SCHOOL PHYSICS

Reasons ex-students who studied physics advise high school students of today to study physics	Number of cases
College prerequisite	22
Fundamental knowledge to understand today's technical society	15
Vocational guidance	7
Helped in occupation	6
Exercised reasoning ability	6
Explained everyday phenomena	5
Interesting course	3
Experience in problem solving	2
General knowledge	2
Practical course	2
Taught principles valuable in mechanics	2
Laboratory techniques	2
Showed the reason for the study of mathematics	1
Armed services	1
Aided in securing employment	1
Stimulated interest in science	1
Basic foundation for later work	1
Challenge	1
Developed confidence in ability to do college work	1
Indicated college not all good times and parties	1

Colleges expressed the opinion that the course in high school was quite adequate scholastically, but suggested the administration of final examinations would be good experience. More field trips, more visual aids of other types, and longer class periods also were suggested. In most instances requests were for more activities of the sort already in use. Two students thought that chemistry should be offered for two years in high school, the first year being general inorganic and the other organic. In only one case was the omitting of anything from the course mentioned. The suggestion was that all material on organic chemistry be omitted. These and other miscellaneous proposals are tabulated on Table XVII.

Table XVIII is based on the opinions of thirty-four ex-students who had studied high school physics. These indicated that a larger number of problems and additional theory should be given. Two wanted the course to include more difficult material, while one respondent held that the course was too formidable. The giving of final examinations was again suggested by three of the thirty-four who replied. Two advised required use of the slide rule.[32]

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[32]In the past, school A gave instruction on the slide rule, but its continued use in the course was optional.

The answers of fifty students who did not study chemistry in high school are the basis for Table XIX. While their

TABLE XVII

SUGGESTIONS OF EX-STUDENTS OF CHEMISTRY FOR IMPROVEMENT OF HIGH SCHOOL CHEMISTRY

Suggested Improvements	Number of cases
More mathematics	17
More laboratory work	14
More advanced work	11
Homogeneous grouping	3
More stress on relation to daily living	2
Final examinations	2
More visual aid	2
Survey course	1
More field trips	1
Omit unit on organic chemistry	1
Give two years of chemistry First year - general inorganic Second year - organic	2
More time for chemistry class	1
More on industrial processes	1
Smaller classes	1
More explanation	1
Seniors only	1
Teacher more objective	1
Less done by students, more by teacher	2
Fewer formulae	2
More formulae	1
Simpler written textbook	1
Projects	1

TABLE XVIII

SUGGESTIONS OF EX-STUDENTS OF PHYSICS FOR IMPROVEMENT OF HIGH SCHOOL PHYSICS

Suggested Improvements	Number of cases
More problems	3
More theory	3
Stiffer course	2
Course too hard	1
More laboratory work	3
Less laboratory work	1
More demonstration experiments	3
Homogeneous grouping	2
Final examinations	3
Use of slide rule	2
Instructor more objective	1
Instructor more outspoken	1
Less emphasis on scientists	1
Broader perspective of field in relation to everyday world	2
More problems on practical everyday work	1
Memorize formulae	1
Learn the why of formulae and emphasize them	1
More emphasis on accurate mathematics	1
Six weeks introductory course on terms used in physics	1
More emphasis on mechanics	1

TABLE XII

OPINIONS OF EX-STUDENTS WHO DID NOT STUDY CHEMISTRY ON THE VALUE OF HIGH SCHOOL CHEMISTRY

Reasons ex-students who did not study chemistry in high school advise high school students of today to study chemistry	Number of cases
Basic information invaluable in everyday life	16
Occupational opportunities	15
Preparation for further study	13
Would not advise study unless interested in science	7
Stimulate latent interests	4
Interesting course	3
Fundamental to understand today's technical society	2
Advances standard of living	1
Exercise logical thinking	1
Household duties	1
Armed service	1

reasons for study were different from those of people who continued their education, many were as emphatic in their assertion that it is a course of value. One even went so far as to propose that chemistry be made a required course for high school graduation. Some gave more than one reason why it should be studied. Sixteen said this course contained information invaluable in everyday life, fifteen listed increased occupational opportunities as a benefit accruing from its study. This can readily be realized as true in this community overshadowed by the petro-chemical industry. Seven who did not go to college felt that unless the individual were already interested in science, he should not be advised to study high school chemistry.

Table XX is a summary of the data from eighty-five former students who did not study physics in high school. Their opinions were similar to those expressed for the study of chemistry. Sixteen said the study of physics gave basic information invaluable in everyday living. Eleven listed it as a must for those who plan further study. The demand for trained scientists was mentioned by nine. Two people said physics was a course with value for the bright student only.

Information from students. Questionnaires were returned from 566 students enrolled in chemistry and/or physics and 185 not enrolled in either course. Table XXI is the educational plan of the participating students. It shows the number of

TABLE XX

OPINIONS OF EX-STUDENTS WHO DID NOT STUDY PHYSICS ON THE VALUE OF HIGH SCHOOL PHYSICS

Reasons ex-students who did not study physics in high school advise high school students of today to study physics	Number of cases
Basic information invaluable in everyday living	16
Preparation for those who plan further study	11
Demand for trained scientists	9
Prerequisite for college	8
Interesting course	3
Occupational opportunities	3
Stimulate latent interest	3
Value for bright student only	2
Valuable mathematical application	1
Knowledge of electricity	1
Conversation	1
Production of musical sound	1

TABLE XXI

EDUCATIONAL PLAN OF PARTICIPATING STUDENTS

School	Number of cases	Per cent going to college	Per cent in college preparatory courses		Per cent not going to college	Per cent in college preparatory courses		Per cent undecided about college	Per cent in college preparatory courses	
			yes	no		yes	no		yes	no
A[1]	127	95	95	5	2	50	50	3	50	50
A[2]	80	64	55	45	30	12	88	6	20	80
B[1]	83	98	99	1	1	100	---	1	100	---
C[1]	84	97	95	5	2	100	---	1	---	100
C[2]	59	75	86	14	16	9	91	9	25	75
D[1]	19	100	84	16	---	---	---	---	---	---
D[2]	27	59	56	44	36	---	100	5	---	100
E[1]	11	100	82	18	---	---	---	---	---	---
E[2]	2	---	---	---	---	---	---	---	---	---
F[1]	16	94	80	20	6	---	100	---	---	---
G[1]	15	100	93	7	---	---	---	---	---	---
G[2]	20	65	69	31	35	---	100	---	---	---
H[1]	121	92	92	8	5	83	17	3	100	---
Totals[1]	566	97	91	9	2	84	17	1	83	17
Totals[2]	185	66	67	13	29	11	89	5	23	77

[1]Indicates group enrolled in science.
[2]Indicates group not enrolled in science.

cases registered in each of these courses under discussion and the number not registered in either of the courses. Of individuals planning on going to college it shows the per cent taking a college preparatory course and the per cent not taking college preparatory work. Of those not enrolled in science it shows the per cent going to college and the per cent not going to college. The per cent undecided about their future completed the table.

Four main reasons influenced students to enroll in chemistry and/or physics. The number of cases motivated by each is given in Table XXII. The college entrance requirement was the incentive causing the largest number of students to enroll in these courses, followed closely by a desire on the part of the students to know the reasons underlying phenomena they had observed but could not understand. In six schools, students signed up for these courses to broaden their background. They repeatedly stated that knowledge of science is necessary for living in today's technical society. Many students felt that no reason other than interest inherent in the course justified the time required. Students from two schools listed retention of membership in science clubs as the reason they signed up for one of these courses.

The majority of students believed the decision to study chemistry or physics was their own as is shown in Table XXIII. In school E, 30.77 per cent said they were motivated

TABLE XXII

FACTORS INFLUENCING STUDENTS TO ENROLL IN CHEMISTRY AND/OR PHYSICS

School	Influence	Number of cases
A	Required for college entrance	64
	Wanted to know reason	74
	Well rounded education	1
	Foundation for later study	6
	Retain membership in science club	2
	Enjoy science	4
	Sounded interesting	4
B	Required for college entrance	28
	Wanted to know reason	17
	Foundation for later study	1
	Well rounded education	1
	Enjoyment	5
C	Required for college entrance	32
	Wanted to know reason	38
	Well rounded background	2
	Enjoyment	4
	Liked science teacher	4
	Credit for graduation	1
	To be in class with friend	1
	Value for future	1
	Foundation for college	1
D	Required for college entrance	10
	Wanted to know reason	8
	Developed a better understanding	1
	Enjoyment	2
E	Required for college entrance	1
	Wanted to know reason	5
F	Required for college	13
	Wanted a good science background	1
G	Required for college entrance	9
	Wanted to know reason	1
H	Required for college entrance	56
	Wanted to know reason	35
	Foundation for college sciences	9
	Develop reasoning ability	1
	Enjoyment	13
	Liked science teacher	2
	Retain membership in science club	1
	Credit for graduation	1
	Interested in learning something new	2

TABLE XXIII

PEOPLE INFLUENCING STUDENTS TO ENROLL IN CHEMISTRY AND/OR PHYSICS

	Influence				
Schools	Teacher Per cent	Parent Per cent	Sibling Per cent	Friend Per cent	Made own decision Per cent
A	0.54	12.50	4.34	7.61	74.46
B	4.12	8.24	2.06	4.12	80.41
C	1.18	1.18		2.35	95.29
D	10.00		35.00	5.00	50.00
E	30.77			7.69	61.54
F	7.14				92.86
G		21.43	7.14		71.43
H	6.19	7.22	1.03	4.12	81.44
Totals	8.56	10.11	9.91	5.17	75.97

by a teacher, in school D, 35.00 per cent were influenced by a brother or a sister. In school G, 21.43 per cent admitted they were persuaded by their parents. The percentage who made their own decisions ranged from a low of 50.00 per cent in school D to a high of 95.29 per cent in school C.

There were seventy-eight occupations listed that the students hoped to undertake as shown in Table XXIV. They ranged from accountant through x-ray technician, engineers leading with 117 hopefuls. Fifty-two were undecided on what vocation they would like to follow. Twenty-eight planned to become teachers, with two specifically designating that they hoped to become chemistry teachers. One girl said she would become a Dominican nun and one boy wanted to become a priest. Nine listed the general heading of scientists, while seven said chemists, one entomologist, four foresters, seven geologists, one geophysicist, one inventor, two mineralogists, one naturalist, three physicists, and one wanted to go into the field of wild game and fish. Out of a total of 448 occupations listed, two hundred twenty-one or 49.33 per cent plan careers of a scientific nature. Despite the fact that most teachers of science have felt chemistry and physics should be courses for "all American youth," and despite the fact that ex-students and students said these courses were fundamental to meet intelligently the daily problems of life in this technical age, about half of the enrollees were people planning a career

TABLE XXIV

OCCUPATIONS STUDENTS ENROLLED IN CHEMISTRY AND/OR PHYSICS HOPE TO ENTER

Occupation	School A	B	C	D	E	F	G	H	Total
Accountant	1	3						1	5
Agriculture	3		1						4
Aircraft designer		1							1
Airline hostess	1								1
Architect	2	1	3						6
Artist	1	3	1	1					6
Athlete	1								1
Aviator		1							1
Business	4		2			1		5	12
CPA								2	2
Chemist	3	2						2	7
Church work	1							1	2
Criminologist		1							1
Dentist	2	1	2					3	8
Designer	1							1	2
Dietician								1	1
Draftsman								1	1
Dramatist		1		1					2
Engineer	31	19	28	3	3	11	6	16	117
Entertainer			1						1
Entomologist				1					1
Fashion designer		1							1
Farmer	2								2
Forester	2		2						4
Geologist	2		3				1	1	7
Geophysicist			1						1
Housewife	1		1						2
Interior decorator		1					1		2
Insurance agent	1							2	3
Inventor								1	1
Journalist		1	1						2
Laboratory tehcnician	2	1	1	1				1	6
Landscape architect	1								1
Lawyer			3					7	10
Machinist			1						1

TABLE XXIV (continued)

OCCUPATIONS STUDENTS ENROLLED IN CHEMISTRY AND/OR PHYSICS HOPE TO ENTER

Occupation	School A	B	C	D	E	F	G	H	Total
Mechanic		1							1
Medical field		1							1
Medical technologist	2	1							3
Military		1	1	1					3
Mineralogist	1		1						2
Minister		1						1	2
Model			1						1
Mortician			1						1
Musician	2	1	1						4
Naturalist	1								1
Naval officer			1						1
Nun	1								1
Nurse	9	5	5	1		1		6	27
Office worker				1					1
Oil business								1	1
Personnel man		1							1
Pharmacist	8	1	2	1	1			2	15
Physician	9	10	3	1		1	1	5	30
Pipefitter			1						1
Photographer			1						1
Physical therapist	1								1
Physicist	1	1	1						3
Pilot								1	1
Priest								1	1
Radio and television		2	1					2	5
Rancher			1						1
Refinery worker			1						1
Reporter			1						1
Research scientist	2	2	1						5
Salesman						1			1
Secretary	1	1	1			1		2	6
Scientist	3		1					1	5
Social scientist	2	2							4
Statistician	1								1
Steel worker			1						1
Teacher	10	5	1	4	1	1		6	28

TABLE XXIV (continued)

OCCUPATIONS STUDENTS ENROLLED IN CHEMISTRY AND/OR PHYSICS HOPE TO ENTER

Occupation	School A	B	C	D	E	F	G	H	Total
Undecided	26	10	7	1		1	3	4	52
Veternarian	2					1		3	6
Welder			1						1
Welfare worker					1				1
Wild game and fish	1								1
X-ray technician								1	1

definitely based on science. The majority of the remainder are people who hoped to enter college.

Of the 323 listings of what students liked best about their science course, experiments led with 142, or 43.96 per cent, according to Table XXV. The term "interesting" followed second in listing, having been mentioned forty-four times, or 13.69 per cent. Reasons for everyday phenomena, having what the students referred to as a good teacher, and explanations were mentioned next most often. Class discussions were enjoyed by eleven individuals, and the same number also made the blanket statement that they liked everything.

In Table XXVI, although students from schools B, E, and H mentioned no dislikes and students from school F made no reply, there were fifty-nine dislikes mentioned. Seven students listed lack of time. This it seemed might be construed favorably as indicating the students wanted more time in chemistry and physics courses. The next dislike was stated by five students in school D, who said they were troubled by having too many different teachers. (This particular school was plagued with frequent loss of their science teachers.) Again this goes deep into the lack of people trained in science rather than being an inherent characteristic of a course. One student disliked experiments, two disliked not having enough experiments, three objected to home work, and two to lack of discussion. One disapproved of research;

TABLE XXV

WHAT STUDENTS PRESENTLY ENROLLED IN CHEMISTRY AND/OR PHYSICS LIKED BEST ABOUT THE COURSE

Liked best	Number of cases according to schools								
	A	B	C	D	E	F	G	H	Total
Aroused interest in mathematics			1						1
Challenge to mind				1	2				3
Class discussions		2	8				1		11
Consumer science	1								1
Demonstrations	2		2					1	5
Easy course			1						1
Everything	3		1	1				6	11
Everyday applications			1						1
Experiments	44	16	45	5	1		10	24	142
Explanations	4		6	1			1	4	16
Field trips			2	2			1		5
Good teacher	1	1	9	1	1		1	2	16
Grades			2					1	3
Individual work	4		1						5
Interesting activities	3								3
Interesting new subject matter	7	12	14	7			2	4	46
Lectures	1		7						8
Nothing				3				4	7
Order	1								1
Practical		1							1
Problem solving	2	1	2				3	1	9
Projects		1							1
Research	1								1
Reasoning	1		3						4
Reasons for everyday phenomena	4		7	1			1	4	17
Using hands other than for writing	2								2
Variety aids	3								3
Vocational implications					1				1
Visual aids		2							2

TABLE XXVI

WHAT STUDENTS NOT PRESENTLY ENROLLED IN CHEMISTRY AND/OR PHYSICS DISLIKED ABOUT COURSE

	Number of cases								
	School								
Disliked	A	B	C	D	E	F	G	H	Total
Changing teachers too often				5					5
Dull				1					1
Experiments			1						1
Formulae			1						1
Homework	1		2						3
Lack of discussion			2						2
Lack of time			4				3		7
Lectures			1						1
Memorizing unusable facts			1						1
Not enough experiments	1		1						2
Not enough field trips			1						1
Not enough research				1					1
Too much research				1					1
Not enough textbook work			1						1
Notebook	1						1		2
Notes			5						5
Poor discipline			1						1
Problems	1						3		4
Teacher			7						7
Teacher presentation	1								1
Technical vocabulary			1						1
Tests			4						4
Theories				1					1
Too much work			1				1		2
Uninteresting							1		1
Workbook	1		1						2

Note: No dislikes were reported from schools B, E, F, and H.

another objected to too much research. Five were opposed to taking notes, and one criticized the course for poor discipline in the class. Four disapproved of problems, while seven, all in one school, disliked the teacher. Four objected to tests, one the instructor's presentation, and one the technical vocabulary. Two objected to the use of a workbook.

The findings of the students' likes and dislikes of various methods of teaching are graphically shown in Figures 3, 4, 5, and 6. Students have indicated on the scale from one to nine their preferences for the course to be taught, with the number one indicating the technique liked best and number nine that liked least. They have used the same number as many times as necessary if two or more techniques were liked equally well by them. If any item represented a procedure they would not want in a class they have marked it "dislike". All items in these findings marked "dislike" are graphed as number ten. Any such item represents a very strong feeling on the part of the students against its use in the classroom. The largest number of first choices, or 168, indicated they wanted individual laboratory work. One hundred sixty-four gave first choice to teacher explanation of the difficult material with the students learning the easy material by themselves. One hundred thirty-four wanted the teacher to select and organize the material to be covered. There were 126 firsts given to lectures by the teacher.

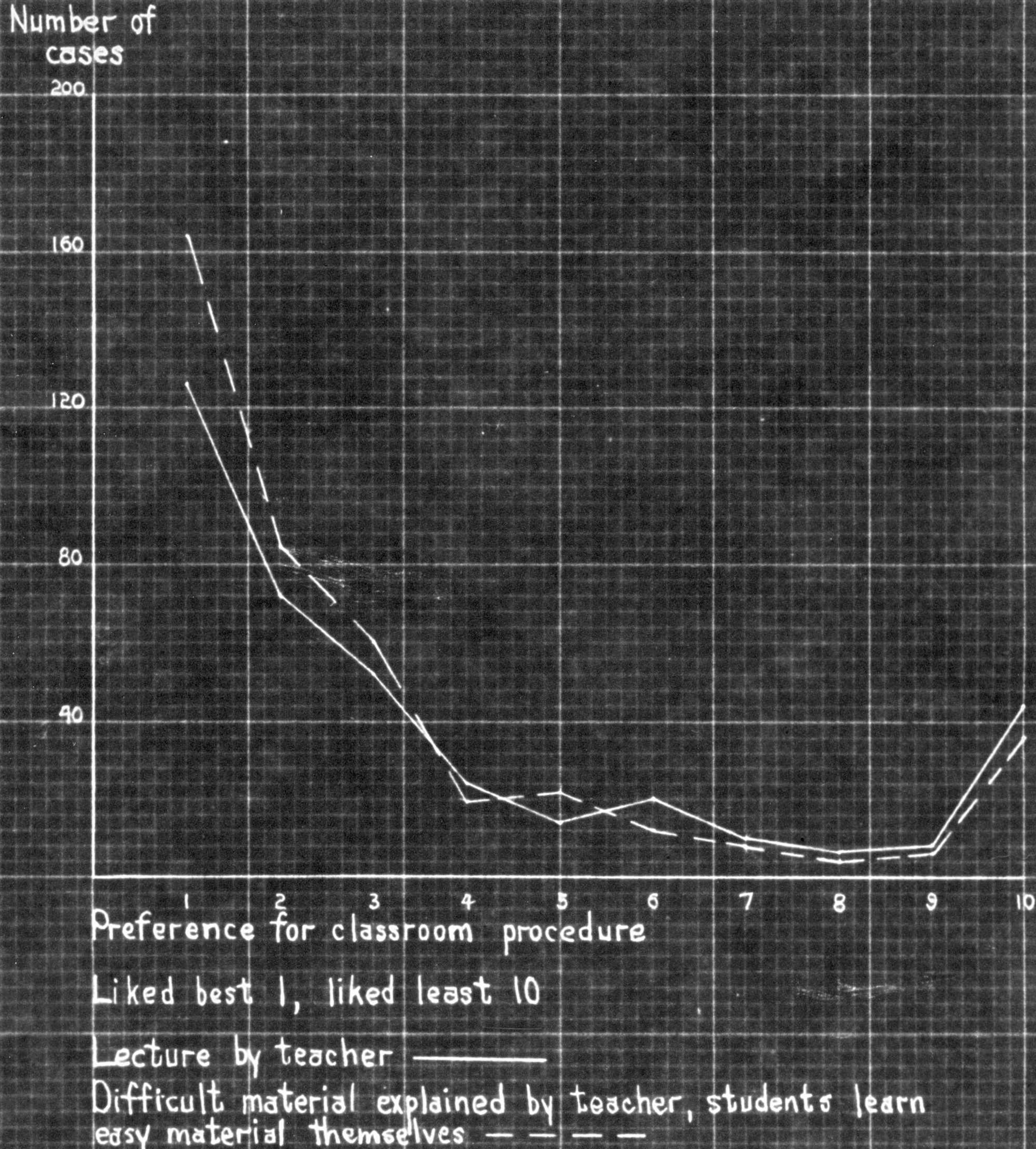
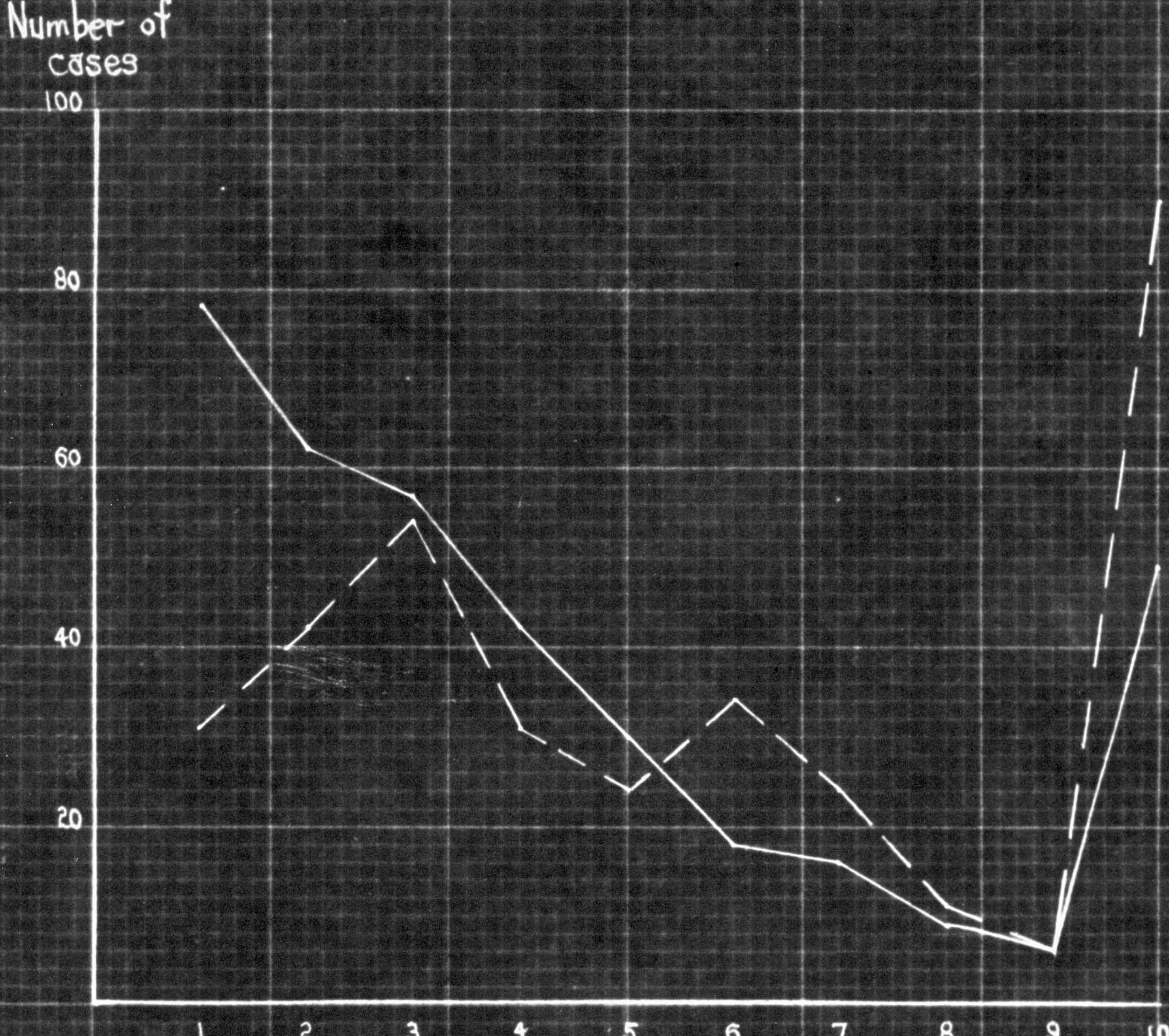


FIGURE 3

TECHNIQUES OF TEACHING CHEMISTRY AND/OR PHYSICS—M



Preference for classroom procedure

Liked best 1, liked least 10

Demonstration experiment performed by teacher ———

Demonstration experiment performed by student - - - -

FIGURE 4

TECHNIQUES OF TEACHING CHEMISTRY AND/OR PHYSICS – N

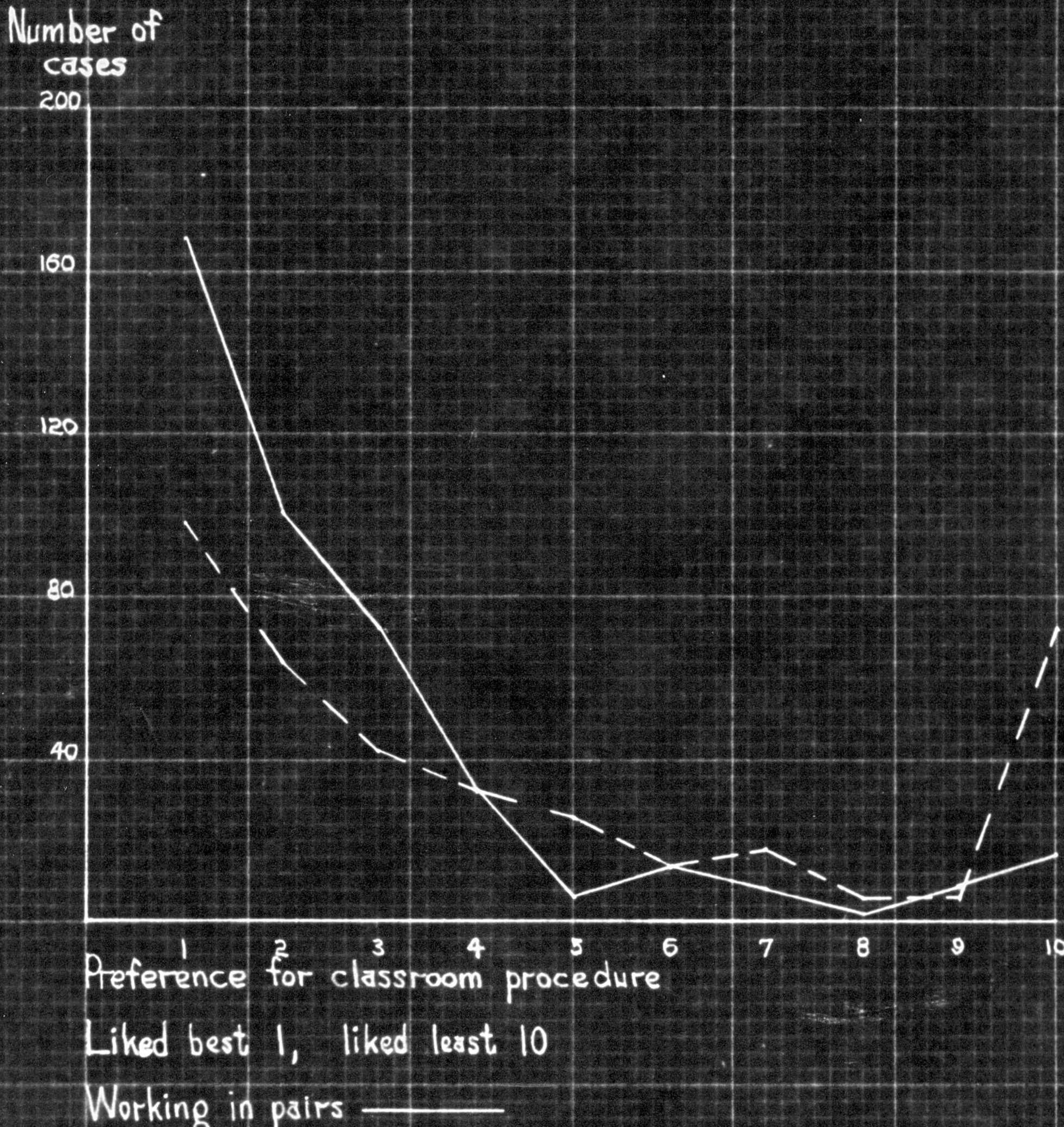
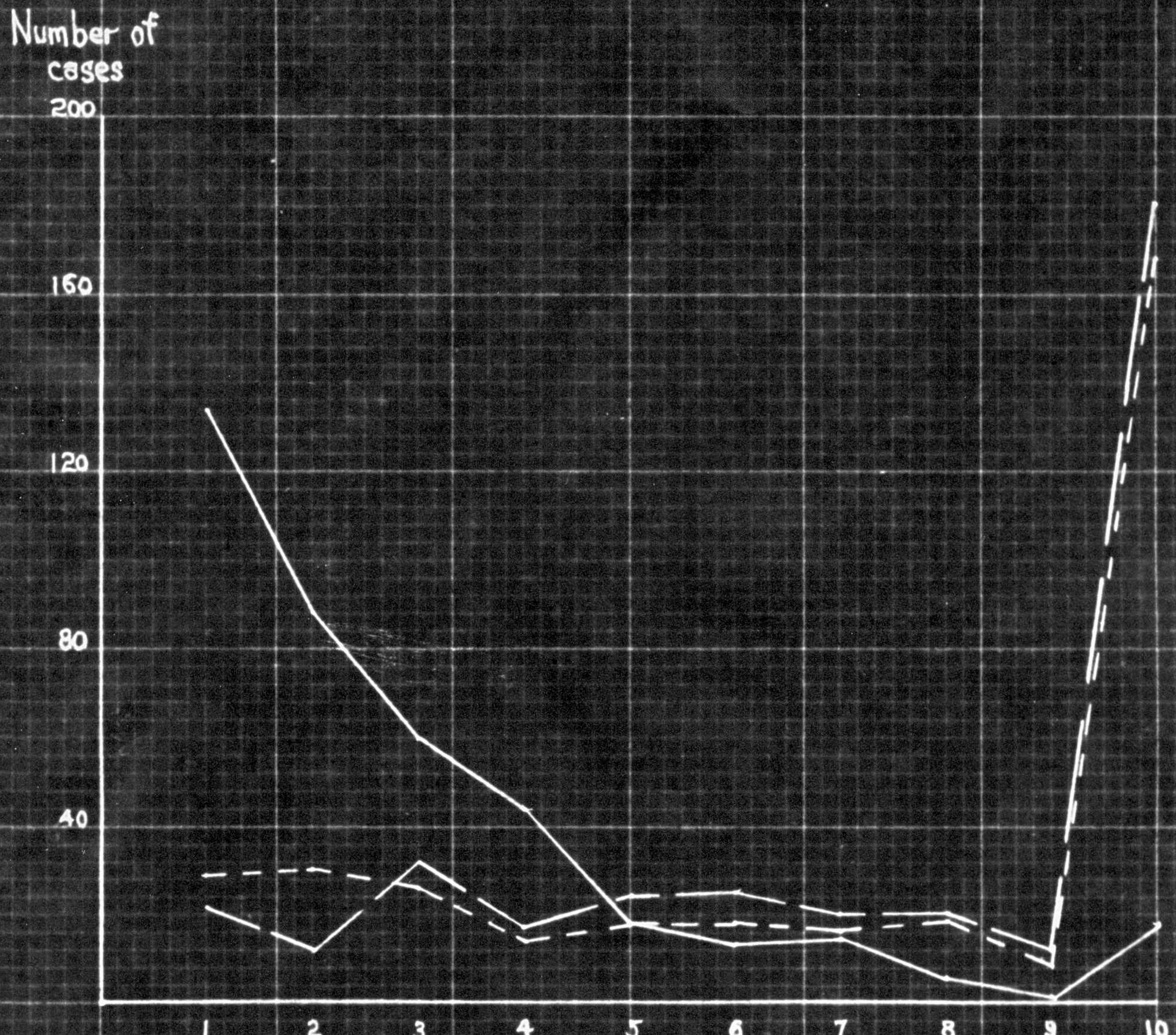


FIGURE 5

TECHNIQUES OF TEACHING CHEMISTRY AND/OR PHYSICS – O



Preference for classroom procedure

Liked best 1, liked least 10

Teachers plan and organize material ————

Students plan and organize by selecting material for course — — — —

Students plan work in committees —— ——

FIGURE 6

TECHNIQUES OF TEACHING CHEMISTRY AND/OR PHYSICS - P

Ninety-eight gave firsts to students working in pairs to perform their experiments. All five of these techniques were given a large number of second and third choices. Few students gave any of these preceding techniques ratings of more than three. Seventy-eight gave demonstration experiments by the instructor first choice, in contrast to thirty who gave first choice for demonstration experiments by the student. One student commented that he liked demonstrations if he were the student who performed the experiment; otherwise, he did not like them. Fifty said they disapproved of demonstrations done by the teacher while ninety-two objected to them done by students. Forty-four disapproved of lectures by the instructor while thirty-six disapproved the teacher's explaining only the difficult material and leaving the easy subject matter for the boys and girls to learn on their own. There were eighteen who objected to students working in pairs to do experiments and seventy-two who disliked individual laboratory exercises where each student performed his own experiment. The fewest firsts, only twenty-two, were given to the technique of the students forming into committees, planning, and carrying out the work as a committee assignment The next least number of ones, thirty, were given to students selecting the material to be covered in the course. The preceding two techniques led with most dislikes, 168 for the students selecting the material, and 180 for the students forming into committees, planning the work, and carrying it out as committee assignments.

Suggestions of the 1953-54 students of chemistry and/or physics for improvements in these courses were tabulated and placed in Table XXVII. "More experiments" listed by thirty-nine individuals appeared more than twice as often as the next item, more and better laboratory equipment. Since both of these items applied to the laboratory, it seemed that students felt improvement in these high school courses was synonymous with improvement in experimentation. More field trips and more explanation were proposed. Students from five different areas requested that their high school work be correlated closely with college courses. Seven asked that arrangements be made for increased time for experimentation, demonstrations, and field trips. Smaller classes, clearer explanation, better discipline, a larger number of movies, and additional lectures appeared equally often. There were requests that added material be covered, and that the subject matter covered be studied in more detail. Some wanted only the most capable students taught with the less capable or those creating discipline problems not allowed to continue in the course. While a few asked for less homework, an equal number requested more outside assignments. About the same number requested more student participation that asked for more teacher demonstrations. Two students requested that the

TABLE XXVII

1953-54 CHEMISTRY AND/OR PHYSICS STUDENT SUGGESTIONS FOR IMPROVEMENTS IN COURSES OF CHEMISTRY AND PHYSICS

Suggested Improvements	Schools								
	A	B	C	D	E	F	G	H	Total
Better explanations			6						6
Better discipline			4				2		6
Better laboratory equipment and space	6	3	1	1			2	2	15
Better teacher			1						1
Better textbook			1						1
Cover only important material			1						1
Cover material in more detail			1			1		2	4
Cover more material	2	1	1						4
Discussion at beginning of year to allow students to plan activities		1	1						2
Fewer problems			1						1
Get rid of uninterested students		1							1
Go slower						1			1
Guest speakers	1								1
Homogeneous grouping college preparatory non-college preparatory	2		4						6
Less homework	1	1						1	3
Less relation to everyday life			1						1
More discussion	2			1					3
More experiments	4	9	14	3	1	3	1	4	39
More explanation	1	3	2			2		1	9
More field trips		2	1	4	1	2			10
More general course		1							1
More individual work	2								2
More lectures by teacher	1		4						5
More like college courses	2	1	2	1				2	8
More moving pictures		2	1	3					6
More outside assignments		1	1						2
More problems		2	2						4
More projects			1	1					2
More review			1						1
More student participation	1		1						2
More teacher demonstrations	1	1							2
More time	2	4						1	7
More vocational applications		1	2						3
More vocational guidance				1					1
Nothing	5		1						6
Outline of course		1	1						2
Smaller classes		2	4						6
Study production methods		1							1
Study technical vocabulary					1				1
Teach only most capable		1	2						3

instructor prepare a written outline of the course to be given to the boys and girls, while two proposed that time be given at the beginning of the year for the students to plan the activities that should be carried out.

The same items that were suggested to improve the course were also listed to make it more enjoyable. Table XXVIII indicated no differences based on the locality in which the schools were located. Most frequently mentioned was more experimentation. This appeared twenty-five times each from students in schools A and C and was listed a total of ninety-four times. More explanation had the next most requests, less than half as many suggesting it as suggested the preceding item. Twenty-six students in four schools requested more field trips. Two of these schools were located in an industrial area, and two in a college area. More films, more teacher demonstrations, homogeneous grouping, less homework, better order, and the elimination of the uninterested and the incapable individuals were mentioned about an equal number of times by students from all schools. As classroom equipment, more comfortable chairs were recommended.

Table XXIX was designed to reflect the opinions of 1953-54 high school chemistry students on the value of this subject. Schools D and F do not schedule chemistry in odd numbered years; hence there appears no information in this table from these schools. Again there seemed to be no clear pattern as

TABLE XXVIII

1953-54 CHEMISTRY AND/OR PHYSICS STUDENT SUGGESTIONS FOR MAKING CHEMISTRY AND PHYSICS MORE ENJOYABLE

Suggestions	Schools								
	A	B	C	D	E	F	G	H	Total
Be told what will happen in an experiment before performing experiment	1								1
Better equipment			1			1			2
Better order	3	1	2						6
Better organization	1		1					1	3
Better teacher			1						1
Better textbook			1						1
Board work			3						3
Class discussion	2	2				1			5
Clearer examples			3					1	4
Closer supervision by teacher			1					1	2
Cover material in more detail	1	1						1	3
Discussion of experiments	2								2
Each student perform own experiment	1		1						2
Enjoy as is	4					1			5
Experiments on individual interest of students								1	1
Fewer experiments		2							2
Fewer interruptions		1							1
Fewer laboratory reports		3							3
Fewer problems		3	1						4
Fewer tests			1				1	1	3
Get rid of uninterested students	4		4					1	9
Get rid of incapable students	4		4						8
Go faster	2							1	3
Go slower	2	3	1				2	2	10
Guest speakers from industry		2						2	4
Have drawings of experiments instead of writing it up	1	1				1		2	5
Homogeneous grouping	3		4				1	1	9
Individual laboratories	1								1
Larger laboratories	1								1
Less explanation								3	3
Less extraneous talk	1							1	2
Less homework	3			1				3	7
Less outside noise	1		4						5

TABLE XXVIII (continued)

1953-54 CHEMISTRY AND/OR PHYSICS STUDENT SUGGESTIONS FOR MAKING CHEMISTRY AND PHYSICS MORE ENJOYABLE

Suggestions	Schools								
	A	B	C	D	E	F	G	H	Total
Let students do whatever they wish		1							1
Longer periods	3	6							9
More advanced course	1							1	2
More about the atom	1							1	2
More class discussion			1				1		2
More comfortable chairs							2	3	5
More displays			1						1
More experiments	25	11	25	1	3	10	6	13	94
More explanations	3	7	20			1	5	4	40
More field trips	11	6				6		3	26
More films	4	3	1					1	9
More help in studying for tests	1								1
More homework	1								1
More individual attention	1							2	3
More individual work	1		2						3
More laboratory equipment		3						4	7
More library work	1								1
More practical applications	1	1	4						6
More projects			2						2
More research	1								1
More review	1		3					1	5
More student participation	1		1					2	4
More study by me	3		2					1	6
More teacher demonstration	1		2				1	4	8
More textbook study	1								1
News of new discoveries	2								2
No detailed explanation	1							2	3
No homework			1						1
No "pop" tests			1						1
Panel discussions and student lectures	1								1
Read textbook aloud in class			1						1
Smaller classes			4						4
Social period						1			1
Stick to subject matter	1								1
Teacher outline course		1	1						2
Tests more often	2		1						3
Tests over laboratory work	1								1
Work problems on board		1	1						2

TABLE XXIX

OPINIONS OF STUDENTS ENROLLED IN CHEMISTRY IN 1953-54 ON THE VALUE OF HIGH SCHOOL CHEMISTRY

Reasons students enrolled in chemistry think it is valuable	Number of cases						
	Schools						
	A	B	C	E	G	H	Total
Broadens background	12	11	7		1	6	36
Challenge				2			2
College preparation	35	4	3	2	8	9	53
Credit	1					2	3
Develop study habits	1					2	3
Exercise in reasoning	1	1	2	1	1	3	9
Explanation of principles underlying everyday phenomena		1	2		1		4
Foundation for further study	9	3				8	20
General information	9	4	1		2	11	25
Help in occupation	4					1	5
Help secure job						1	1
Interesting course	10	1	1			9	21
Practice everyday applications	17		2			3	22
Stimulates thinking	4				1	7	12
Understanding of world in which we live	40	7	11		2	14	74
Understanding principles of everyday phenomena	9	6	7			7	29
Vocational guidance	4					2	6

determined by type of community. The greatest value of high school chemistry in the eyes of the teen-ager is its college preparatory value. Broad background, understanding the principles underlying everyday phenomena, general information, practical everyday applications were next in line in value in their belief. The total times these closely related items were mentioned, which is its value for "all American youth", would far outnumber the college preparatory value. Next most often named was foundation for further study. Then were cited understanding the world in which we live, stimulating thinking, and exercising reasoning. Vocational guidance was suggested by a number. One individual said the course showed him he could never become a successful engineer, while six said their interest was aroused so they felt for the first time they should like to go into some field of science.

The actual count of the opinion of students enrolled in high school physics for 1953-54 on the value of high school physics can be seen in Table XXX. Schools E and G could not be included in this table since E does not have adequate numbers of students to offer more than one physical science and G schedules physics in even numbered years. Again the single response leading was college preparation followed by general information and a practical course for everyday living. The next most important response as determined by numbers was to broaden background and to understand the

TABLE XXX

OPINIONS OF STUDENTS ENROLLED IN PHYSICS IN 1953-54 ON THE VALUE OF HIGH SCHOOL PHYSICS

Reasons students enrolled in physics think it is valuable	Number of cases						
	Schools						
	A	B	C	D	F	H	Total
Basic information	1						1
Broadens background		4		3			7
Change attitudes			2				2
College preparation	6	17	3		5	8	39
Creates objective approach to life			1				1
Develops study habits	1		2	2			5
Enable to understand causes						1	1
Exercise in reasoning	3	1			2		6
Foundation for future study	4	1					5
General information		6	7	2		1	16
Help in occupation		2		1	1		4
Helps meet crisis with level head			1		1		2
Interesting course		2		1	1		4
Necessary for armed services				1			1
Practical course for everyday living		4	1	4	1		10
Stimulates curiosity			2				2
Stimulates thinking			2	2		2	6
Understanding principals of everyday phenomena	2	3			1	1	7
Vocational guidance			1				1

principles of everyday phenomena. To develop desirable study habits was listed as one of the values for this course. Exercise in reasoning and stimulation of thinking were mentioned six times each.

Students not enrolled in chemistry or physics for 1953-54 have made many statements to explain why they did not select these courses. These statements have been classified as shown in Table XXXI. Schools B, F, and H did not return questionnaires for pupils not enrolled in science. Thirty-three said they did not enroll for these courses because they just were not interested. Twenty-five said they were too difficult, an opinion that does not seem valid in view of the findings in this study, which showed that a higher percentage of failure in physical science than in the school as a whole is the exception according to Table V, page 26.

III. ANALYSIS OF DATA

Teacher personality and enthusiasm seemed to be one of the greatest forces in determining the enrollment in physical science courses. In school A, where the chemistry teachers gave much time to developing an active club, the chemistry enrollment has increased by leaps and bounds simultaneously with the growth of this co-curricular activity. In the same school, where the physics teacher has not sponsored any sort of extra-curricular activity, the enrollment in physics has

TABLE XXXI

REASONS FOR NOT ENROLLING IN CHEMISTRY
AND/OR PHYSICS IN 1953-54

Reasons	Schools A	C	D	E	G	Total
Dislike physics teacher	3					3
Dislike teacher		2				2
Did not enjoy science in past	6	2	3		1	12
Do not know	1					1
Fear of accident	1					1
Fear of failure	9	2	1		3	15
Inadequate mathematics	2	1				3
Inadequate prerequisites		2	2			4
Impossible to schedule	7	19	3		6	35
Mid-term graduate	3					3
Not going to college	4	1	1			6
Not interested	18	14	2		4	38
Not needed	9	4	1			14
Not planning to enter science field	1					1
Not required for college entrance	1					1
Not required	1					1
Only seniors allowed to enroll				2		2
Other courses more valuable	4	4	4		2	14
Passed all science courses	1	2				3
Passed chemistry	10	13				23
Plan to schedule next year	3	4	1		2	10
Prefer other courses	11	6				17
Science teacher suggested other course		2				2
Teachers not good		2				2
Teachers too hard	1					1
Time for fun in senior year	1					1
Too difficult	11	9	7		2	29
Too much homework		2				2
Too little time for class	1					1

decreased 60 per cent in the last ten years. In school C where disapproval of the teacher's personality was unmistakable, the percentage enrollment was the lowest of any of the eight schools. In school H where the fine rapport between the students and teachers was obvious, the largest enrollment was found in physics and the largest enrollment of the four big schools was found in chemistry.

The highest percentage of enrollment in chemistry and physics was found in the schools located in an agricultural area. These were small schools that were able to schedule only one physical science each year. These courses in the larger schools had to maintain their enrollment in the face of competition from numerous other courses in the broad offerings of their secondary curriculum. In all of the small schools, where there could not have been a wide choice for selection, the enrollment was unusually high. There was a higher enrollment in the college dominated institutions than there was in the districts located in industrial areas.

Fear of failure was given by many students as their reason for not enrolling in these courses. This reputation of difficulty in view of the figures did not seem valid for chemistry. Percentage of failure in chemistry was 3.80 per cent while for the schools as a whole the percentage of failure was 4.00 per cent. The percentage of failure in physics for all schools was 5.90 per cent. The 2.31 per cent enrollment in physics in school A might have well reflected the 10 per cent failures. School C with a 14.00 per cent failure in physics had a 2.59 per cent enrollment. The other schools offering physics had a low percentage of failure and a correspondingly higher percentage enrollment.

All schools except the very smallest practice the usually accepted techniques thought to popularize courses. Since the techniques of field trips, clubs, guest speakers, assembly programs based on science were used in varying degrees in all schools except the smallest, no conclusion on their effectiveness could be drawn.

It seems, perhaps that the graphs representing students' antipathy to pupil planning of courses and committee work by students may not be altogether fair. Most people have a certain amount of inertia to overcome before embracing new ideas, and this is particularly true in education, where procedures have continued for generations simply because they were practiced in the past. Again, teachers probably have not had enough experience in these newer techniques to handle them skillfully. In the investigator's classes of 132 chemistry students there was definite indication that committee work was better accepted in May than had been true in December when the questionnaires were filled in. In these same classes the students seemed to have enjoyed panel discussions thoroughly, although there was no reference to them in the questionnaires.

Techniques to improve the courses and techniques to make courses more enjoyable seemed to be synonomous terms in the minds of students. About the same suggestions were made for both.

IV. SUMMARY

Despite the fact that students, ex-students, most teachers, and principals believed chemistry and physics were courses for "all American youth", these classes were composed essentially of college preparatory students. Few boys and girls who did not plan continued formal education beyond high school graduation were found in these courses. One of the participating teachers thought physical sciences should be taught only to those students with high aptitude and interest for science and a few of the former students concurred in this opinion.

In the four schools where only one of the two physical sciences was offered each year, the enrollment was markedly higher than the average of the four larger participating schools. The chemistry enrollment for all participating schools was 9.14 per cent and the physics enrollment was 4.25 per cent.

The science teacher had a key position in proper motivation. His responsibility to influence the student for or against continued interest was large.

From the viewpoint of the student, ex-student, teacher, and principal, individual laboratory exercises were an essential part of chemistry and physics.

Students wanted to understand subject matter in place of just memorizing laws and principles. Projects which involved active participation by all members of a class were very satisfying. Pupils liked to talk. If boys and girls were able to present reports and panels on current science topics they and their classmates enjoyed it more than listening to a teacher present the same material. They particularly liked the study of the structure of the atom. The theory of electrons, protons, neutrons, and mesons fascinated them. They objected to writing, particularly notebooks and summaries of experiments. They liked tests administered at short time intervals.

Ex-students believed the use of the slide rule should be included as a compulsory part of physics curriculum.

Although fear of failure was listed by many students as a reason for not registering for chemistry and physics, the per cent of failure in chemistry was below that in the schools as a whole and only in two schools was failure in physics markedly high.

The largest percentage of enrollment in the physical sciences was found in the small agricultural schools where physics and chemistry were alternated, the next largest enrollment was found in college dominated areas and the smallest percentage of enrollment was in schools located in industrial areas.

CHAPTER IV

SUMMARY AND CONCLUSIONS, RECOMMENDATIONS, AND NEED FOR FURTHER RESEARCH

I. SUMMARY AND CONCLUSIONS

The present investigation was undertaken (1) to determine the enrollment of students in chemistry and physics in southeast Texas, and (2) to learn what procedures were practiced in schools where these courses were attractive to the teen-ager.

1. The chemistry enrollment of 9.14 per cent in the participating schools was 20.26 per cent higher than the national matriculation of 7.60 per cent, and only 0.96 per cent below the peak enrollment of 1890. The physics registration of 4.25 per cent was 1.16 per cent under the national average of 4.30 per cent. In no school was there over 10 per cent of non-college preparatory students present in a physical science class; the average for all schools was 3.25 per cent.

2. The small agricultural schools where physics and chemistry were alternated, and where there was a correspondingly smaller choice of electives than in the larger institutions, had the largest percentage of enrollment in these courses. The next largest enrollment was found in college dominated areas, and the smallest percentage of enrollment

was in schools located in industrial areas.

3. The concensus was that "all American youth" need a scientific background in order to live successfully in our technical society. Those who plan formal education beyond the high school level require a scientific background for further study.

4. Students who desired to become proficient in the physical sciences were faced with the almost insurmountable task of mastering a large technical vocabulary, but the majority conquered this because they felt the need for that subject matter for further education and for life in an age of science.

5. Pupils enjoyed much of what they saw, for demonstrations, field trips, and other visual aids were high on the list of vitalizing activities.

6. Through student approval of talks made by visiting scientists, chemistry and physics were made to come alive. Rapport was established between the community and the classroom.

7. Learners liked teachers' lectures when they contained clear explanations.

8. Boys and girls delighted in both individual work and work with others where they themselves had opportunity for participating in the activities.

9. A poor science teacher could not arouse the interest

of the teen-ager. Pupils confused the dislike for a particular teacher and his methods with dislike for the course. Hence, poorly trained elementary and junior high school science teachers deterred students from a continued study of science. In the questionnaires boys and girls constantly reiterated they liked "a good science teacher" and they disliked "a poor science teacher". Undoubtedly the teacher was a big factor in the size of the enrollment. Students wanted an enthusiastic, sympathetic person, well trained in the fundamentals of science and in methods of teaching.

II. RECOMMENDATIONS

In so far as the results of this investigation may be valid, the following recommendations seem justified:

1. The Texas Education Agency should investigate the feasibility of coordinating scheduling of science courses so that all schools which alternate chemistry and physics offer chemistry the same year, and likewise schedule physics the same year.

2. Teacher training institutions should require that all prospective elementary and junior high school science teachers study general science.

3. Encouragement should be given prospective school personnel to enter the field of science teaching.

4. Science teachers should be paid on the same basis

for scientific co-curricular activities as is paid for additional work in athletics.

5. Personnel should be compensated for necessary work involved in taking care of supplies and equipment, setting up demonstration experiments, preparing for student laboratory experiments, and arranging field trips. They should have time to devise and to organize demonstrations and to think of the best methods for the presentation of subject matter.

6. Teachers have an obligation to their students to acquaint them with occupational opportunities in the field of science, not only the well known ones based on professional training, but also the many non-technical fields open to the secondary school graduate with training only in high school science.

7. In order to meet the demands of the students, teachers must not only love their work and be intellectually alert, but they must know their subject matter, be able to devise experiments on the ability level of their students, and know about films and other visual aids - and how to obtain and use them. They must constantly guard their vocabularies to substitute simpler synonyms for difficult non-technical words. School personnel should always be willing to keep abreast of current professional information and to try new methods.

8. Today to live successfully and happily a person

needs experience in science along with certain skills and information that will enable him to appreciate his scientific environment. To prepare a teen-ager to live intelligently in this technical world, to read newspapers and periodicals understandingly, and to enter conversation knowingly, a course in physical science should be presented for those students who do not plan to continue their formal education after graduation from high school.

9. Increased efforts are needed to guide non-college preparatory students into chemistry and physics.

10. More time should be arranged for science classes to permit field trips, demonstration experiments, and student experiments.

11. Better laboratory facilities with equipment and space adequate for interested students to perform individual investigations are to be desired.

12. The textbook should be selected with care. It should be written simply enough for all students to be able to read understandingly, but should have added material that will challenge even the most capable.

13. Pupils should be given aid in learning how to study.

14. Students should be given the opportunity for practice in taking semester examinations.

15. There should be closer cooperation between the school and the community, in order to make it feasible to

bring into the school outstanding local scientists.

III. NEED FOR FURTHER RESEARCH

1. Research studies in the area of subject matter content should be made to determine long term values to be secured by the student.

2. In the face of constant recommendations for more laboratory work, additional field trips, increased visual aids, added explanations to an already crowded curriculum, subject matter should be appraised and reviewed to find what may be deleted.

3. For every type of methodology approved by one group of students, another group disapproved. Studies need to be carried on to find how chemistry and physics can be better adapted to the individual differences of the learners.

4. Studies are needed to find how facilities and time can be made available for those who wish to use school property for individual research.

5. Investigations are needed to learn how more non-college preparatory students may be encouraged to study the physical sciences.

6. Studies are needed to find means to induce all teachers to enter in-service training so all may realize the value of science to our country, the United States of America, to industry, and to every individual.

7. Investigations should be made to find proper compensation for science teachers for the additional time necessary for caring for equipment, arranging individual experiments, setting up demonstrations, and taking students on field trips.

8. Research is needed to determine the qualifications for successful teachers of junior high school science. Additional studies should be made to learn the qualifications for successful teachers of chemistry and physics.

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APPENDIX

QUESTIONNAIRE SENT TO PRINCIPALS OF
THE PARTICIPATING SCHOOLS

_____ 1. What is the total enrollment in your school in grades ten through twelve?

_____ 2. What per cent of your graduates go to college?

_____ 3. What per cent of non-college preparatory students enroll in chemistry and physics?

4. What factors make these science courses popular?
   a.
   b.
   c.

5. What factors make these science courses unpopular?
   a.
   b.
   c.

6. What is the percentage of failures in
   _____ a. chemistry?
   _____ b. physics?
   _____ c. school as a whole?

7. In order to popularize science does your school
   _____ a. have one or more science clubs?
   _____ b. sponsor field trips to neighboring scientific industries?
   _____ c. do you encourage teachers to plan field trips for students?
   _____ d. bring in scientists from local industries to speak to students?
   _____ e. have assembly programs based on science?

8. Please make suggestions as to how you think chemistry and physics teachers might improve their courses.

_____ 9. Should an advanced general science course, the content of which is to make the student conscious of the scientific world in which he lives, be required for all students who do not take either chemistry or physics?

10. Does your school offer applied science courses, such as,
   _____ a. consumer chemistry?
   _____ b. household chemistry?
   _____ c. physics?
   _____ d. other?

_____ 11. Do you think such courses should be scheduled?

QUESTIONNAIRE SENT TO CHEMISTRY AND PHYSICS TEACHERS OF THE PARTICIPATING SCHOOLS

1. What is the total enrollment in the science courses you teach?
   ______ a. Physics
   ______ b. Chemistry
   ______ c. Biology
   ______ d. General Science
   ______ e. Other

2. What do the students like best about the course you offer?
   a.
   b.
   c.

3. What do the students like least about the course you offer?
   a.
   b.
   c.

4. What are the reasons more students do not enroll in chemistry?
   a.
   b.
   c.

5. What are the reasons more students do not enroll in physics?
   a.
   b.
   c.

______ 6. Do you do demonstration experiments?

______ 7. Do the students perform individual experiments?

______ 8. Do you take your students on field trips?

______ 9. Do you affiliate with the Texas Junior Academy of Science?

______ 10. Should chemistry and physics be taught only from the college preparatory point of view?

______ 11. Should high schools offer a science course above biology especially for non-college people?

QUESTIONNAIRE SENT TO CHEMISTRY AND PHYSICS
TEACHERS OF THE PARTICIPATING SCHOOLS
(continued)

_____ 12. Should a high school chemistry and physics course be offered that omits all mathematics?

_____ 13. Should students who have difficulty with algebra be encouraged to enroll in chemistry and physics?

_____ 14. Do your students have an opportunity to perform original investigations during school hours?

_____ 15. Are your courses correlated with the occupational opportunities in your area?

16. List and give the enrollment of the co-curricular activities sponsored by the science department.
a.
b.
c.

17. What methods have you found most effective in your science teaching?
a.
b.
c.

18. What else might be done to increase chemistry and physics enrollment?
a.
b.
c.

QUESTIONNAIRE SENT EX-STUDENTS OF ONE OF THE PARTICIPATING HIGH SCHOOLS

There is a greater demand for people trained in science than can be supplied by those presently being trained. Will you help us to find out how we can interest more people in science by answering this questionnaire?

_____ 1. What year did you graduate from high school?

_____ 2. Did you attend college?

 _______ a. Where?
 _______ b. How long?
 _______ c. Degree?
 _______ d. What did you study in college?
 _______ e. What is your present occupation?

_____ 3. When you were in high school did you study chemistry?

_____ 4. When you were in high school did you study physics?

5. Why would you advise a high school student of today to study chemistry?
 a.
 b.
 c.

6. Why would you advise a high school student of today to study physics?
 a.
 b.
 c.

7. In what ways do you think high school chemistry helped you?
 a.
 b.
 c.

8. In what ways do you think high school physics helped you?
 a.
 b.
 c.

_____ 9. If you had known as a high school student what you know now would you have enrolled in chemistry?

_____ 10. Would you have studied physics?

QUESTIONNAIRE SENT EX-STUDENTS OF ONE
OF THE PARTICIPATING HIGH SCHOOLS
(continued)

11. In what ways do you think your high school chemistry course could have been changed that would have improved it?
    a.
    b.
    c.

12. In what ways do you think that your high school physics course could have been changed that would have improved it?
    a.
    b.
    c.

QUESTIONNAIRE SENT STUDENTS ENROLLED IN CHEMISTRY AND/OR PHYSICS

There is a great demand for trained scientists, but not enough trained people to supply the demand. Will you help to find out what can be done to interest more students in science by filling in the following questionnaire?

Classification: (check one) Junior Boy
Senior Girl

Check the science courses you have passed:
physics general science
chemistry other
biology

Check the science courses in which you are now enrolled:
physics biology
chemistry other

_____ 1. Are you taking a college preparatory course?

_____ 2. Do you plan to enter college?

_____ 3. What do you hope to study in college?

4. If you plan to go to college to study in a non-scientific field, what value do you think high school physical science courses are for you?
   a.
   b.
   c.

5. If you do not plan to go to college, what value do you think high school physical science courses are for you?
   a.
   b.
   c.

_____ 6. What occupation do you hope to follow when you go to work?

7. Check the person who influenced you to enroll in chemistry and/or physics:
   a. Parent
   b. Teacher talked you into it
   c. Like a science teacher
   d. Brother

QUESTIONNAIRE SENT STUDENTS ENROLLED
IN CHEMISTRY AND/OR PHYSICS
(continued)

e. Sister
f. Friend
g. Other
h. Made own decision

8. If you made your own decision, check the reason:
   a. Wanted to know reason for things you have noticed.
   b. Required for college entrance.
   c. To retain membership in science club.
   d. Other.

_____ 9. Did you enjoy science courses you have had in the past?

10. What did you like best about your science courses?
   a.
   b.
   c.

11. Check one, two, three, etc. in the order of your preference for a course to be taught. If two or more items are liked equally well by you, give them the same number. If any item represents classroom procedure you would not want in a class, mark Dislike beside it.
   a. Lecture by teacher.
   b. Explanation of difficult material by teacher with students learning easy material on their own.
   c. Students select material to be covered in course.
   d. Students form into committees, plan work, and carry out as committee assignment.
   e. Material organized and planned by teacher.
   f. Individual laboratory work where each student conducts his own experiment.
   g. Students work in pairs, but all students perform same experiment on same day.
   h. Demonstration experiment performed by student.
   i. Demonstration experiment performed by teacher.
   j. List any other procedures you would enjoy.
      (1)
      (2)
      (3)

_____ 12. Do you have too many tests in science?

_____ 13. Do you cover too much material before you have tests?

QUESTIONNAIRE SENT STUDENTS ENROLLED
IN CHEMISTRY AND/OR PHYSICS
(continued)

14. What might be done that has not been done to make your science course more enjoyable?
    a.
    b.
    c.

15. What could be done in science courses to make them better fitted to your needs and desires?
    a.
    b.
    c.

_____ If you are a junior, do you plan to enroll in the other physical science next year?

_____ If you are a junior and you do not plan to enroll in a physical science next year, why not?

(To be filled in by students who have passed chemistry and/or physics)

_____ 1. Did you find chemistry or physics difficult?

2. Did you find it necessary to do more homework in chemistry or physics? (check one of the following answers?)
    _____ a. than in other courses?
    _____ b. less than in other courses?
    _____ c. about the same as in other courses?

_____ 3. Was your grade in chemistry or physics higher than your average grades?
    _____ a. about the same as your average grades?
    _____ b. lower than your average grades?

_____ 4. Were you afraid of a possible accident in the laboratory?

QUESTIONNAIRE SENT STUDENTS NOT ENROLLED IN
CHEMISTRY OR PHYSICS

There is a great demand for trained scientists, but not enough people to supply the demand. Will you help to find out what can be done to interest more students in science by filling in the following questionnaire? In the spaces to the left answer yes or no.

Classification: (Check one) Junior Boy
Senior Girl

_____ Do you plan to go to college?

_____ Are you taking a college preparatory course?

Check the science courses you have passed.

_____ Physics _____ General Science
_____ Chemistry _____ Others
_____ Biology

_____ Did you enjoy the science courses you have had in the past?

1. What did you like best about your science courses?
   a.
   b.
   c.

2. What did you dislike about your science courses?
   a.
   b.
   c.

3. Why did you not elect chemistry or physics this year?
   a.
   b.
   c.

(To be filled in by students who have passed chemistry or physics)

_____ Did you find chemistry difficult?

_____ Did you find it necessary to do more homework in chemistry or physics than in other courses?

QUESTIONNAIRE SENT STUDENTS NOT ENROLLED IN
CHEMISTRY OR PHYSICS
(continued)

______ Less than in other courses?

______ About the same as in other courses?

______ Was your grade in chemistry or physics higher than your average grades?

______ Lower than your average grades?

______ About the same as your average grades?

______ Were you afraid of a possible accident in the laboratory?

Why did you enroll in chemistry or physics this year?
a.
b.
c.