1953

Nationwide status study of the integrated course in physical science

BOSTON UNIVERSITY

SCHOOL OF EDUCATION

Thesis

NATIONWIDE STATUS STUDY OF THE INTEGRATED COURSE IN PHYSICAL SCIENCE

Submitted by

Sister M. Amadeus Ray

(B.S., St. Joseph College, 1942)

In Partial Fulfillment of Requirements for

the Degree of Master of Education

1953

First Reader: John G. Read
Professor of Science Education

Second Reader: Clem W. Thompson
Assistant Professor of Physical Education

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

THE PROBLEM

<u>Statement of the problem</u>.-- The purpose of this study is to present an accurate account of the status of the integrated course in Physical Science in senior high schools throughout the United States. It must be noted that Physical Science as considered in this paper, is not General Science as it is taught in Grade IX, but a more advanced course which integrates such sciences as Physics, Chemistry, Astronomy, Meteorology, and Geology. It is planned for Grades XI and XII, and occasionally for Grade X.

<u>Scope of the problem</u>.-- This study has been conducted on a nationwide basis. Teachers of Physical Science from 40 schools in various parts of the United States have contributed information about the integrated course in their schools. All of these schools are in communities which have a population of 5,000 and over. The writer has assumed that larger communities are more likely to offer the new course than are smaller ones, an assumption which is supported by Miles in his conclusions drawn from Watson's study, "Survey Courses in Physical Science: Their

Status, Trends and Evaluation." Miles states, "Such courses exist in schools of all sizes but are more common in the larger schools."[1]

Selection of the problem.-- Studies of educational trends indicate that Physical Science is becoming an established course in the senior high-school curriculum. Although it had been discussed and suggested earlier, it did not appear widely until about 1937. In 1940, Watson[2] reported that of 250 cities with a population of over twenty-five thousand, 54, or 21.6 percent, offered a fused course in physical science in at least one high school. Since then, Physical Science has become more widely known and teachers more curious about its possibilities. The fact that science educators have been working intensively on courses of study and on text books is also an indication that interest in the field is growing. From 1937 to 1948, seven such texts have appeared.[3]

In 1951, The National Science Teachers Association,

1/Vaden W. Miles, Principles and Experiments for Courses of Integrated Physical Science, Edwards Brothers, Inc., Ann Arbor, Michigan, 1950, p. 32.

2/Donald R. Watson, "A Comparison of the Growth of Survey Courses in Physical Science in High Schools and in Colleges," Science Education (January, 1940), 24:14-20.

3/Frank C. Guffin, Development of an Advanced General Science Course Designed for Use in High School at the Eleventh Grade Level, Unpublished Master's thesis, University of Texas, 1948, p. 8.

in its symposium Physical Science Today,[1] recognized the growing interest in integrated science courses:

> "At the recent meeting of the Physics Section of the Central Association of Science and Mathematics Teachers, about 50 of the group remained more than half an hour beyond scheduled closing time to continue a discussion of physical science and the curriculum."

The Association states further:[2]

> "The recent U. S. Office of Education report, The Teaching of Science in Public Schools (pp. 22-23) lists by titles 11 different groups of alternate courses offered, apparently, in addition to, or in lieu of, the usual general science, biology, chemistry, and physics; further, the report indicates that about 19 per cent of the high schools offer one or more such courses. More than half of the courses reported fall into the physical science area."

Studies have been made comparing the achievement of students who have taken integrated courses with those who have taken traditional courses in physics and chemistry. In connection with work for his doctoral dissertation Peterson[3] prepared his own physical science examination and administered it to both groups, statistically equated according to intelligence quotient and chronological age. He found that the higher scores were obtained by students who had completed the fused course.

1/Robert H. Carleton, Physical Science Today, The National Science Teachers Association, Washington, D. C., 1951, p. 2.

2/Loc. cit.

3/Shailer Peterson, "The Evaluation of a One-Year Course, the Fusion of Physics and Chemistry, With Other Physical Science Courses," Science Education (December, 1945), 29: 263.

The investigations carried on to date have been, for the most part, limited to certain localities or to a certain phase of the subject. It is hoped that this thesis will present the results of a sampling of the present status of integrated Physical Science in the senior high schools of the United States; that it may encourage enterprising teachers to persevere by informing them of what others are doing in the field; and that it may bring to the attention of administrators the possibility and desirability of integrated science courses in their curricula.

CHAPTER II

THE PROCEDURE

<u>Preliminary survey of states</u>.-- In order to determine which communities were teaching Physical Science, a letter (Exhibit 1, Appendix) was sent to every State Department of Education, asking that the names of cities teaching the integrated course be checked. Enclosed with each letter was a complete list of communities in the state, which, according to the Educational Directory of 1951, had a population of 5,000 and over.

Replies were received from 40 states. Nine of these stated that Physical Science was not taught in any of the cities listed. One of the nine, Oregon, reported that Physical Science is taught, but only in the schools of communities having a population under 5,000. The reason for this, as Mr. Cliff Robinson, Director of Secondary Education in Oregon, explained in a letter to the writer, dated July 31, 1951, is as follows:

> "Oregon is characterized by great areas of sparse population. More than half or our secondary schools have seven teachers or less. We have 3 two-teacher high schools with enrollments of less than 20 and perhaps as many as 15 three-teacher high schools. We advocate that the schools which are too small to include chemistry and physics, even on an alternate year basis, should offer a physical science course in their program of studies.

> ". . . We are of the opinion that we need a low-level physical science course which could be taken by those students at perhaps the junior or senior year who lack the ability to take part in the regular physics and chemistry courses. So far we have not made any noticeable progress in this direction, but I do believe it is coming.
>
> "I am sorry that we are not able to take an active role in your survey. The size of cities which you have established in your criteria just does not fit the Oregon scene."

The Departments of Education from seven states did not have sufficient data on hand to supply the names of cities offering the fused course.

Twenty-four states returned the list of cities after having checked those in which Physical Science is being taught.

Survey of schools.-- Using these lists as a guide, and also a list of schools suggested to the writer by Dr. Vaden Miles of Wayne University, Detroit, Michigan, a letter was sent to the principals of 100 secondary schools, 90 of which are located in communities which were reported by the State Departments of Education to be teaching the integrated course. A letter and a questionnaire (Exhibit II, Appendix) for the science teacher were enclcsed with each principal's letter.

Seventy schools responded to the questionnaire. Forty of these are offering the course; the other thirty are not. The names of the 40 schools participating in this study appear in Table I.

Table 1. Names and Locations of 40 Schools Teaching a Course in Physical Science

Names of Schools	Location	
	City	State
Anniston High School	Anniston	Alabama
Central High School	Florence	Alabama
Parrish High School	Selma	Alabama
Pine Bluff High School	Pine Bluff	Arkansas
Los Angeles High School	Los Angeles	California
S. Pasadena Senior High School	South Pasadena	California
Boulder High School	Boulder	Colorado
College High School	Greeley	Colorado
Derby High School	Derby	Connecticut
Bulkeley High School	Hartford	Connecticut
New Britain Senior High School	New Britain	Connecticut
Stratford High School	Stratford	Connecticut
Armstrong Technical High School	Washington	D. of C.
Arlington Heights High School	Arlington Hts.	Illinois
Manhattan Senior High School	Manhattan	Kansas
Pittsburg Senior High School-	Pittsburg	Kansas
East Wichita High School	Wichita	Kansas
Highlands High School	Fort Thomas	Kentucky
Edward Little High School	Auburn	Maine
Bangor High School	Bangor	Maine
Thornton Academy	Saco	Maine
Pittsfield Senior High School	Pittsfield	Massachusetts
Ann Arbor Senior High School	Ann Arbor	Michigan
Central High School	Flint	Michigan
Biloxi High School	Biloxi	Mississippi
Bass Senior High School	Greenville	Mississippi

Table 1. (concluded)

Names of Schools	Location	
	City	State
Beatrice Senior High School	Beatrice	Nebraska
Hastings High School	Hastings	Nebraska
North High School	Omaha	Nebraska
Phillips Exeter Academy	Exeter	New Hampshire
Montclair High School	Montclair	New Jersey
Eastside High School	Paterson	New Jersey
Summit High School	Summit	New Jersey
New Hanover High School	Wilmington	North Carolina
Will Rogers High School	Tulsa	Oklahoma
Scott High School	Coatesville	Pennsylvania
Watertown Senior High School	Watertown	South Dakota
Austin High School	Austin	Texas
University High School	Morgantown	West Virginia
Wisconsin High School	Madison	Wisconsin

CHAPTER III

THE FINDINGS

Spread of Physical Science.--- Since the first major appearance of Physical Science in 1937, it has spread rapidly and has become an important part of many high-school curricula. When Watson conducted his survey in 1940[1] most of the schools offering Physical Science were in California. In 1948, Guffin reported that 69 secondary schools in Texas were offering the course.[2] Although no other states have been found where it is quite so predominant, it can be clearly seen from Table 1 that the schools taking part in this survey represent every section of the country except the extreme Northwest. It is also interesting to note that 19 of the 40 schools have adopted the course since 1945. There is no indication that the introduction of Physical Science has ceased, or even lessened, but the trend seems rather to be in the opposite direction.

The Committee of the Forty-sixth Yearbook, Science Education in American Schools, gives its wholehearted

1/Donald R. Watson, Survey Courses in Physical Science: Their Status, Trends, and Evaluation, Unpublished Doctor's dissertation, University of Southern California, 1940, p. 8.

2/Frank C. Guffin, op. cit., p. 13.

approval to the establishment of integrated science courses, and expresses its belief that such courses are spreading:1/

> "Many fused courses of physical science have been introduced into the senior high school during the last decade. Moreover, the number of such courses seems certain to increase. It is quite as logical to develop such a course at the present time as it was to begin the development of general biology about thirty-five years ago."

Table 2 presents the number of schools teaching Physical Science according to the year of its adoption into the curricula. Since 5 of the 40 schools failed to supply information about the date of its introduction, the schools numbered total only 35.

Size of registration.-- The number of students registered for Physical Science is astonishingly great. In 1938-39, Ferguson2/ found 13,568 students enrolled in Physical Science in 270 schools. Although in her questionnaire the writer did not ask for the exact size of each class, the average number of students registered was requested. By totaling these "averages" the writer finds

1/Committee on the Teaching of Science, National Society for the Study of Education, Science Education in American Schools, Forty-sixth Yearbook, 1947, Part I, The University of Chicago Press, Chicago, Illinois, p. 45.

2/William C. Ferguson, "Instructional Problems of Generalized Science in the Senior High School," Science Education, XXIV (February, 1940) pp. 72-75.

Table 2. Summation of Schools according to the Year in which Physical Science was Introduced into the Curricula

Year	Number of Schools
1935	3
1936	1
1937	2
1938	2
1940	3
1941	2
1942	1
1943	1
1944	1
1945	2
1946	1
1947	3
1948	2
1949	6
1950	2
1951	3

that there are approximately 2,600 students taking Physical Science in 38 schools. (Two schools did not furnish information in regard to the size of classes.) The registration in each division ranges from 13 to 35, most classes accommodating about 25 students. Fifteen schools are able to fit all Physical Science students into one class. Ten others find 2 divisions necessary. The number of sections in the remaining schools varies from 3 to 11. Each school with its divisions and average registration in Physical Science, and also its average total registration, is listed in Table 3.

Table 3. Average Registration of Students in Each Division of Physical Science Compared with Average Registration of Entire School

Name of School	Number of Divisions	Average Registration in Each Division	Average Total Registration
Anniston H. S. Anniston, Alabama	1	30	1,380
Central H. S. Florence, Alabama	1	21	567
Parrish H. S. Selma, Alabama	5	30	439
Pine Bluff H. S. Pine Bluff, Arkansas	2	25	739
Los Angeles H. S. Los Angeles, Cal.	1	30	2,769
S. Pasadena Sr. H. S. S. Pasadena, Cal.	4	27	1,033
Boulder H. S. Boulder, Colorado	4	20	648
College H. S. Greeley, Colorado	4	20	218
Derby H. S. Derby, Connecticut	1	?	459
Bulkeley H. S. Hartford, Conn.	1	20	1,528
New Britain Sr. H. S. New Britain, Conn.	7	19	2,222
Stratford H. S. Stratford, Conn.	5	23	1,367
Armstrong Tech. H. S. Washington, D. C.	1	25	1,729
Arlington Hts. H. S. Arlington Hts., Ill.	5	22	684
Manhattan Sr. H. S. Manhattan, Kansas	1	15	512
Pittsburg Sr. H. S. Pittsburg, Kansas	5	25	520
East Wichita H. S. Wichita, Kansas	11	30	2,609
Highlands H. S. Fort Thomas, Ky.	1	25	494
Edward Little H. S. Auburn, Maine	2	35	730
Bangor H. S. Bangor, Maine	2	35	771

Table 3. (concluded)

Name of School	Number of Divisions	Average Registration in Each Division	Average Total Registration
Thornton Academy Saco, Maine	1	30	490
Pittsfield Sr. H. S. Pittsfield, Mass.	3	25	1,426
Ann Arbor Sr. H. S. Ann Arbor, Mich.	1	20	1,153
Central H. S. Flint, Michigan	2	?	3,018
Biloxi H. S. Biloxi, Miss.	1	24	691
Bass Sr. H. S. Greenville, Miss.	1	20	845
Beatrice Sr. H. S. Beatrice, Nebraska	2	25	479
Hastings H. S. Hastings, Nebraska	2	27	1,723
North H. S. Omaha, Nebraska	2	32	1,783
Phillips Exeter Acad. Exeter, New Hamp.	7	13	720
Montclair H. S. Montclair, N. J.	2	20	1,430
Eastside H. S. Paterson, N. J.	2	20	2,757
Summit H. S. Summit, N. J.	3	28	626
New Hanover H. S. Wilmington, N. C.	1	30	1,918
Will Rogers H. S. Tulsa, Oklahoma	7	35	1,544
Scott H. S. Coatesville, Pa.	1	30	
Watertown Sr. H. S. Watertown, S. D.	1	25	472
Austin H. S. Austin, Texas	4	25	2,462
University H. S. Morgantown, W. Va.	2	30	454
Wisconsin H. S. Madison, Wisconsin	1	15	?

Grade level of Physical Science students.-- Grades XI and XII seem to be, by far, the most popular grades for the teaching of Physical Science. Only 5 of the schools reporting offer it to tenth-grade students exclusively. Five others, however, teach it to tenth, eleventh, and twelfth graders. In South Pasadena, California, one of the 5 places where Physical Science is taught to all 3 grades, the tenth-grade class was begun as recently as September, 1951 as an experiment, whereas eleventh and twelfth-grade Physical Science has been in the curriculum since 1942.

Nineteen schools have students from both eleventh and twelfth grades taking the course; six place it in the twelfth grade curriculum, five in the curriculum for Grade XI.

Titles for the integrated course.-- The greater number of schools have named the integrated course simply Physical Science; yet the author found, besides this, 11 other titles used to describe the same course. These are: Senior Science, Advanced Science, Advanced General Science, Applied Science, Basic Science, Consumer Science, Twelfth-Grade Science, Everyday Science, Modern Science, Integrated Science, and Fused Physico-Chemistry. Despite the large number of course names, the material covered is basically the same, as will be seen later.

Time allotted to class periods.-- The time allotted to Physical Science and the use made of that time varies with each school system and with individual teachers. Six of them, rather than conducting separate lecture and laboratory periods, combine both lecture and laboratory into one class period which is held five days a week during periods which may vary from 50 to 60 minutes in length. Thirteen schools report having no laboratory periods at all, but only lecture periods during which demonstrations are given to the students. Four such schools conduct 50 to 55 minute periods 4 days a week. The other 9 hold classes 5 days a week for periods ranging from 40 to 60 minutes long.

The Physical Science course in 16 of the schools is planned with a definite number of lecture and laboratory periods per week. Again there is a great deal of variety in the method of handling the course. Some schools have 4 lectures and 1 laboratory period, while others have only 1 lecture but 4 laboratory periods per week. Usually the periods are from 40 to 60 minutes long, but in Ann Arbor, Michigan where the course is arranged so that there will be 2 laboratory periods a week, each laboratory period is 96 minutes long.

In 5 schools, the teachers have no set schedule for laboratory work, but use the class time in whatever way is most appropriate for the topic being taught. Table 4 shows the time allotted to Physical Science by each of the 40 schools.

Table 4. Amount of Lecture and Laboratory Time per Week Allotted to Physical Science

Name of School	Lectures: Pds. per week	Lectures: Length of Period in Minutes	Labs.: Pds. per week	Labs.: Length of Period in Minutes	Combined Lecture & lab.: Pds. per Week	Combined Lecture & lab.: Length of Period	Pds. used at discretion of teacher: No. per Week	Pds. used at discretion of teacher: Length of Period
Anniston H. S.					5	60		
Central H. S.	2-3	55	3-2	55				
Parrish H. S.	5	40						
Pine Bluff	5	60						
Los Angeles	3	50	2	50				
S. Pasadena					5	60		
Boulder H. S.							5	56
College H. S.	3	50	2	50				
Derby H. S.	5	40						
Bulkeley H. S.	5	42						
New Britain	4	50						
Stratford	5	41						
Armstrong H. S.	3	45	1	90				
Arlington Hts.					5	58		
Manhattan H. S.					5	60		
Pittsburg H. S.	3	63	2	67				
E.Wichita H. S.	2	55	2	55				
Highlands H. S.	5	55						
Ed. Little H. S.	4	50						

Table 4. (concluded)

Name of School	Lectures: Pds. per week	Lectures: Length of Period in Minutes	Labs.: Pds. per week	Labs.: Length of Period in Minutes	Combined Lecture & Lab.: Pds. per Week	Combined Lecture & Lab.: Length of Period	Pds. used at discretion of teacher: No. per Week	Pds. used at discretion of teacher: Length of Period
Bangor H. S.	5	45						
Thornton	5	50						
Pittsfield					5	55		
Ann Arbor	3	46	2	96				
Central, Flint	2.5	54	2.5	54				
Biloxi H. S.							5	50
Bass Sr. H. S.	3	60	2	60				
Beatrice H. S.							5	60
Hastings H. S.							5	55
North H. S.					5	43		
Phillips Exeter	3	50	1	50				
Montclair H. S.	3-5	44	1-2	44				
Eastside H. S.	5	40						
Summit H. S.	3	53	2	53				
New Hanover							5	60
Will Rogers	4	55						
Scott H. S.	4	55						
Watertown	4	60	1	60				
Austin H. S.	3-4	55	1-2	55				
University	1	60	4	60				
Wisconsin H. S.	1	45	4	45				

Population of classes.-- It seems to be in keeping with the old traditional opinion that boys are more interested in physical sciences than girls, that not one of the 40 schools reports having classes preeminently made up of girls. The classes are quite evenly mixed in 24 schools, but in the other 16, most of the Physical Science pupils are boys.

In only 3 schools are the Physical Science classes composed mainly of college-preparatory students. Twenty-three of the schools state that their Physical Science registration is drawn chiefly from the non-college group. The remaining 14 have classes in which both college and non-college students are fairly evenly represented.

This condition is not surprising when we realize that the children with high ability are, for the most part, not enrolled in the integrated course. Only 7 schools report having any of the brightest pupils registered for Physical Science, and these are part of a heterogeneous grouping in each case. Classes containing students of both average and low ability are carried on in 12 schools. Fairly homogeneous groupings of average students can be found in 11 others, and of students of low ability in the remaining 10.

Registration of Physical Science students in other Science courses.-- Of the 40 schools taking part in this survey, only one, Wisconsin High School, Madison, Wisconsin, refuses to admit pupils to the integrated Physical Science course who have previously taken General Science. Later admission of Physical Science students to separate courses in Physics and Chemistry, however, is not so unanimously agreed upon. Ten schools report that they do not permit pupils who have completed the integrated course to take either Physics or Chemistry. In 6 of the 10, it would be impossible for them to do so at a high school level because they are the schools in which Physical Science is taught to twelfth-grade students only. It is interesting to note that the other 4 schools are ones whose Physical Science enrollments are made up of students of low ability or of a mixed group of average and poor scholars.

Although they are allowed in the separate Physics and Chemistry courses, the greater number of students in 19 schools fail to register for them. In 4 schools the majority does register for Chemistry, and in 2 others, many take either Chemistry or Physics. Mr. Carl V. Gruhn, teacher of Physical Science in South Pasadena, California, states that some of his students enroll in the integrated course after having had Chemistry and some while taking Physics. This same teacher, and four others, report that a fairly large group, although not a majority, elect either Physics or Chemistry later.

<u>Topics covered by Physical Science</u>.-- The particular sciences which are integrated in the Physical Science course vary, but a great many schools - 22 of the 40 contacted - include all 5 mentioned in the writer's questionnaire; namely, Physics, Chemistry, Astronomy, Geology, and Meteorology. Five schools are including units on Biology, and one on Driver Education. The sciences covered by each individual school are shown in Table 5.

Table 5. Topics Covered by Physical Science

Name of School	Topics						
	Phy.	Chem.	Astr.	Geo.	Met.	Biol.	Dr. Educ.
Anniston H. S. Anniston, Ala.	x		x	x			
Central H. S. Florence, Ala.	x	x	x	x	x		
Parrish H. S. Selma, Ala.	x			x	x		
Pine Bluff H. S. Pine Bluff, Ark.	x	x	x	x			
Los Angeles H. S. Los Angeles, Cal.	x	x	x	x	x		
S. Pasadena H. S. S. Pasadena, Cal.	x	x	x	x	x		
Boulder H. S. Boulder, Col.	x	x	x	x	x		
College H. S. Greeley, Col.			x	x	x		
Derby H. S. Derby, Conn.	x	x	x	x	x		
Bulkeley H. S. Hartford, Conn.	x	x	x	x	x		
New Britain H. S. New Britain, Ct.	x	x	x		x	x	

Table 5. (continued)

Name of School	Topics						
	Phy.	Chem.	Astr.	Geo.	Met.	Biol.	Dr. Educ.
Stratford H. S. Stratford, Conn.	x	x	x		x		
Armstrong H. S. Washington, D. C.			x	x	x		
Arlington Hts. H.S. Arl. Hts., Ill.	x	x	x	x	x		
Manhattan Sr. H. S. Manhattan, Kan.	x	x	x			x	
Pittsburg Sr. H. S. Pittsburg, Kan.	x	x	x	x	x	x	
E. Wichita H. S. Wichita, Kan.	x					x	
Highlands H. S. Fort Thomas, Kt.	x	x			x	x	
Ed. Little H. S. Auburn, Maine	x	x	x	x			
Bangor H. S. Bangor, Maine	x	x			x		
Thornton Academy Saco, Maine	x	x	x	x	x		
Pittsfield H. S. Pittsfield, Mass.	x		x		x		
Ann Arbor H. S. Ann Arbor, Mich.	x	x	x	x	x		
Central H. S. Flint, Michigan	x	x					
Biloxi H. S. Biloxi, Miss.	x	x	x	x	x		
Bass Sr. H. S. Greenville, Miss.	x	x	x	x	x		
Beatrice H. S. Beatrice, Neb.	x	x	x	x	x		
Hastings H. S. Hastings, Neb.	x	x	x	x	x		
North H. S. Omaha, Neb.	x	x	x				
Phillips Ex. Acad. Exeter, N. H.	x	x	x	x	x		
Montclair H. S. Montclair, N. J.	x	x	x	x	x		
Eastside H. S. Paterson, N. J.	x	x	x	x	x		

Table 5. (concluded)

Name of School	Topics						
	Phy.	Chem.	Astr.	Geo.	Met.	Biol.	Dr. Educ.
Summit H. S. Summit, N. J.	x	x	x	x	x		
New Hanover H. S. Wilmington, N. C.	x	x	x	x	x		
W. Rogers H. S. Tulsa, Oklahoma	x	x	x	x	x		x
Scott H. S. Coatesville, Pa.	x	x			x		
Watertown H. S. Watertown, S. D.	x	x					
Austin H. S. Austin, Texas	x	x	x	x	x		
University H. S. Morgantown, W.Va.	x	x		x			
Wisconsin H. S. Madison, Wis.	x	x	x	x	x		

<u>Sources of materials</u>.-- Most teachers who answered the questionnaire are using a text, 24 of them for class work as well as for homework. Two make use of it only in class. Another plan, used by 4 teachers, is to assign homework from it, but to use different materials in the classroom. In a few schools, more than one text is being used; a separate text for different grade levels in some places, and a different text for different physical sciences in others. Three teachers report using a text, but only as a reference book.

The number of texts named is more than one-third as great as the number of schools using them. The following is a list of text books arranged according to the frequency with which they were mentioned by the 40 teachers taking part in this survey.

<u>The Physical Sciences</u>, Eby, Waugh, Welch, & Buckingham, Ginn & Co., New York, 1946.

<u>Modern Life Science</u>, Carleton and Williams, J. B. Lippincott Co., Chicago, 1945.

<u>Physical Sciences for High Schools</u>, Hogg, Cross and Little, D. Van Nostrand Co., Inc., New York, 1951.

<u>Consumer Science</u>, Hausrath and Harms, Macmillan Co., New York, 1939.

<u>Senior Science</u>, Bush, Ptacek, Kovats, American Book Co., New York, 1937.

<u>Physical Science</u>, Nettels, Devine, Nourse and Herriott, D. C. Heath & Co., Boston, 1942.

<u>Understanding the Universe</u>, Franklin B. Carroll, The John C. Winston Co., Philadelphia, 1947.

<u>Our Environment</u>, Wood and Carpenter, Allyn & Bacon, New York, 1933.

<u>New World of Science</u>, Burnett et al., Silver Burdett Co., New York, 1948.

<u>Basic Science</u>, Barnard and Edwards, Macmillan Co., New York, 1951.

<u>Everyday Problems in Science</u>, Wilbur L. Beauchamp, Scott, Foresman & Co., New York, 1936.

<u>Science</u>, Davis and Sharpe, Henry Holt & Co., New York, 1947.

<u>Experiences in Physics</u>, L. R. Williard & C. Winter, Ginn & Co., Boston, 1943.

<u>Modern Chemistry</u>, Charles E. Dull, Henry Holt & Co., New York, 1940.

Very few of the teachers are using the text to the exclusion of other sources of information. They also report that work is being done from reference readings. In Beatrice, Nebraska, in addition to a text and reference reading from books, magazines, and newspapers, visiting lecturers are also provided two or three times a month to speak about their own fields of scientific specialization.

Seven teachers find it possible to eliminate the text completely. They are able to get sufficient and valuable material from reference books, workbooks, laboratory manuals, magazines, newspapers, and field trips. This approach leaves them freer to select for study the areas which will be most useful to their particular students in their particular community.

Before closing this chapter, it will be interesting to note the results reported by one physical science teacher who is also working on his own text book, Mr. Carl V. Gruhn of South Pasadena, California. In a communication with the author, he states:

> "In our course we do not have sections on Chemistry, Physics, etc. as such. Instead, we follow certain basic experiences and use the laws from those fields to support our points.
>
> "We have had unusually outstanding work accomplished by students in the course because the sky is the limit as far as student ability is concerned. Each student goes as far as his ability permits. As an example: A girl built a television set as her special problem before television was on the coast.

Now I have a boy who has built a special interferometer and one who is trying to measure the charge of an electron. Others do research in music, art, etc."

In view of this statement it is worth recalling that Mr. Gruhn works with a heterogeneous group of students of high, average, and low abilities. Integration of the physical sciences, then, can be, and most often is, a success.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

__Summary of the survey__.-- This survey is designed to show, on a nationwide scale, the status of Physical Science. Teachers of the integrated science course from 40 secondary schools scattered all over the country have taken part. Their responses to the writer's questionnaire show that each year more schools are including Physical Science in the curriculum, and that the number of students registered for the course is fairly high - approximately 2,600 students in 38 schools. These students are, for the most part, eleventh and twelfth grade boys and girls of average or low ability, who do not intend to go to college. A few of them are in the tenth grade, and some, of high ability, are following a college-preparatory course.

Physical Science is the name used most frequently to describe the integrated course. Many other titles are also in use, but no one of them is widespread.

A definite amount of time is allotted to lecture and laboratory periods in many schools. Many others eliminate individual laboratory work and use the teacher-demonstration method. Only very few schools have no pre-arranged lecture and laboratory schedule, but use class time as best fits the day's needs.

With one exception, students who have previously taken General Science are allowed to register for Physical Science. Only a few, however, continue further with the study of either Physics or Chemistry, even though, in the greater number of schools, they would be allowed to do so.

The integrated course in Physical Science includes topics taken from Physics, Chemistry, Astronomy, Geology, Meteorology, and in five schools, Biology. Text books are widely used, but other source materials such as reference books, scientific magazines and newspapers, supplement them. A few teachers eliminate the text completely and rely solely upon supplementary material.

Conclusions which follow.--

1. There is a growing recognition of the need for integration. This trend will very likely influence permanently the science curriculum of the secondary school.

2. There is an increase in the number of schools offering Physical Science, and in the number of students registered for the course.

3. At present, Physical Science is taught chiefly to the poorer students, but it has been tried - and tried successfully - with all types of students.

4. The individual teacher is left comparatively free to plan and organize his own course. There seems to be no standard syllabus to limit or to force coverage of material.

5. More recent and up-to-date text books are needed.

Recommendations.--

1. Studies dealing with objective statistical evaluation of Physical Science courses would give more valid, worthwhile comparisons of integration and non-integration.

2. Since Physical Science is spreading so steadily, it would be interesting to discover what, if anything, is being done to train teachers for this new approach to science teaching.

APPENDIX

EXHIBIT I

LETTER SENT TO STATE DEPARTMENTS OF EDUCATION

Boston, Mass.
August 2, 1951

Dear Sir:

As part of my work at Boston University, I am undertaking a study of the recently organized course in Physical Science which has been introduced into some of our secondary schools. The course is an integration of such subjects as Physics, Chemistry, Astronomy, Geology, and Meteorology, planned for students of Grades X, XI, or XII.

I have enclosed a list of cities in your state with a population of 5,000 and over. Will you please check the names of those cities in which such a course is taught?

I am extremely grateful for your cooperation in this project.

Very truly yours,

Sister M. Amadeus

EXHIBIT II

QUESTIONNAIRE SENT TO SCIENCE TEACHERS

Name of teacher ____________________
School address ____________________
Number of years teaching Physical Science ____________________

1. In what year was the integrated course in Physical Science introduced into your school? __________
2. By what titles is the course known?
   Physical Science __________
   Senior Science __________
   Consumer Science __________
   Survey Science __________
   (Other) __________
3. How many divisions or sections of the course are there? __________
4. Do you teach all divisions? Yes __________ No __________
5. What is the average registration in each division of the course? __________
6. In what grade is Physical Science offered? (Note that this is not Grade VII, VIII, and IX General Science.)
   Grade 10 __________
   Grade 11 __________
   Grade 12 __________
7. How many lecture periods per week are given to the course? __________
8. How long is each period? __________
9. How many laboratory periods are there per week? __________
10. How long is each? __________
11. Into which of the following categories do Physical Science students fall?
    Boys __________
    Girls __________
    Fairly evenly divided __________

    College preparatory __________
    Non-college students __________
    Both __________

    High Ability __________
    Average ability __________
    Low ability __________
12. Are students allowed to register for Physical Science who have previously taken General Science? Yes __________ No __________

EXHIBIT II (cont.)

13. Are Physical Science students later allowed to register for Physics? Yes________ No________

for Chemistry? Yes________ No________

14. If "yes", have the majority registered for either or both of these courses?
Physics________
Chemistry________
Both________
Neither________

15. What are the main topics covered by the Physical Science course?
Physics________
Chemistry________
Astronomy________
Geology________
Meteorology________

16. Is a text book used? Yes________ No________

If "yes", please write the name, author, and publisher of the text.
Name________
Author________
Publisher________

For what type of study is the text used?
Classroom work________
Homework________
Both________

If "no", from what sources are materials taken?
Reference books________
Laboratory manuals________
Magazines________
Scientific newspapers________
Workbooks________

SELECTED BIBLIOGRAPHY

Bailey, W. W., "Physical Science for the Eleventh Year," Science Teacher, (December, 1942), 9:17.

Barnard, J. Darrell, "Progress Report of the Committee on Research in Secondary School Science," Science Education, (April, 1948), 32:185-187.

Benjamin, Theodore D., "The Modern Role of Physical Science Teaching," Teachers College Record, (January, 1944), 45:272-279.

Blanchet, W. W. E., "Investigation of Student Opinion Concerning Survey Courses in Science," Science Education, (February, 1948), 32:24-32.

Blanchet, W. E. E., "Subject Matter Topics Contained in Textbooks for Use in Survey Courses in the Natural Sciences," Science Education, (March, 1948), 32:88-93.

Blisard, Thomas J., "Developing Physical Science Experiences through the Use of Cooperative Group Processes," Science Education, (December, 1949), 33:366-371.

Cahoon, G. P., "Teaching Science for General Education in the Secondary School," School Science and Mathematics, (April, 1949), 49:281-288.

Carleton, Robert H., "The Acceptability of Physical Science as a College Entrance Unit," Science Education, (April, 1946), 30:127-132.

Carleton, R. H., and H. H. Williams, Modern Life Science. J. B. Lippincott Company, Chicago, 1945.

Carleton, Robert H., "Physical Science for General Education," Science Counselor, (March, 1941), 7:7, (June, 1941), 7:48, (September, 1941), 7:81.

Committee on the Teaching of Science, National Society for the Study of Education, Science Education in American Schools, Forty-sixth Yearbook, 1947. Part I, The University of Chicago Press, Chicago, Illinois.

Eby, George S., C. L. Waugh, H. E. Welch, and B. H. Buckingham, The Physical Sciences. Ginn and Company, Boston, 1943.

Ferguson, William C., "Instructional Problems of Generalized Science in the Senior High School," Science Education, (February, 1940), 24:72-75.

Freud, Henrietta Z., and N. D. Cheronis, "Retention in the Physical Science Survey Course," Journal of Chemical Education, (June, 1940), 17:289-293.

Gruhn, C. V., "Living a Course in Physical Science," California Journal of Secondary Education, (November, 1948), 23:424-428.

Guffin, Frank C., "Development of an Advanced General Science Course Designed for Use in High School at the Eleventh Grade Level," Unpublished Master's thesis, University of Texas, 1948.

Johnson, P. G., "Some Trends in Senior High School Science with Implications for the Preparation of Teachers," Science Education, (February, 1949), 33:13-15.

Laton, Anita D., and Samuel R. Powers, New Directions in Science Teaching. McGraw-Hill Book Company, Inc., New York, 1949.

Mallinson, George G., "The Implications of Recent Research in the Teaching of Science at the Secondary School Level," Journal of Educational Research, (January, 1950), 43:321-342.

Manzer, J. G., "Present and Future Science Courses," Science Education, (April-May, 1945), 29:20-22.

Miles, Vaden W., A Determination of the Principles and Experiments Desirable for a High School Course in Integrated Physical Science. Edwards Brothers, Inc., Ann Arbor, Michigan, 1950.

National Association for Research in Science Teaching, "Progress Report of the Committee on Research in Secondary School Science," Science Education, (April, 1948), 32:185-187.

National Science Teachers Association, Physical Science Today, A Symposium on Present Practices and Perplexing Problems at the Senior High School Level, Washington, D. C., 1951.

Peterson, Shailer, "The Evaluation of a One-Year Course, The Fusion of Physics and Chemistry, With Other Physical Science Courses," Science Education, (December, 1945), 29:255-264.

Rosenlof, George W., and Harold E. Wise, "Experimenting with a Course in Combined Physical Science," *School Review*, (May, 1938), 46:346-356.

Skinner, S. M., "The Two-Year Physical Science Course in the University of Chicago," *School Science and Mathematics*, (October, 1940), 40:631.

Watson, Donald R., "A Comparison of the Growth of Survey Courses in Physical Science in the High Schools and in Colleges," *Science Education*, (January, 1940), 24:14-20.

Watson, Donald R., *Survey Courses in Physical Science: Their Status, Trends, and Evaluation*, Unpublished Doctor's dissertation, University of Southern California, 1940.