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Offerings and Enrollments in the Secondary School Sciences in Kansas in 1954-1955

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A study of *Offerings and Enrollments in the Secondary School Sciences in Kansas in 1951-1952* was published by the authors in 1953 Our intention was to repeat the study after a five-year interval, using the same methods, thus obtaining comparable data for a comparison of results and for future studies of trends.

Because there is a continuing demand for copies of the 1953 study, and the supply is exhausted, it was thought wise to repeat the study at this time, even though the elapsed interval has been only three years.

In the Forty-sixth Yearbook of the National Society for the Study of Education (1947) appears this statement: "In order to formulate a plan of education for prospective teachers of science in junior and senior high schools, it is advisable first to consider the kinds of positions and responsibilities science teachers generally fill." Because beginning teachers of science in Kansas high schools must adjust themselves to conditions existing in small schools where the typical science teacher teaches not only the sciences but one or more non-science courses, the prospective science teacher and his advisor should know the conditions under which the teachers must work. This paper presents some of the data we believe to be important in a consideration of various aspects of the job of the high school science teacher, the high school administrator, and the institutions confronted with the responsibilities of preparing science teachers for the schools of Kansas.

The purpose of this study is to show (1) the offerings and enrollments in the sciences in Kansas high schools; (2) the subjects taught by Kansas high-school science teachers; (3) some of the trends as revealed by comparison with previous studies; and (4) some comparisons with the national situation in science education.

Previous Studies

Johnson (1950) published for the United States Office of Education a survey of the teaching of science in public high schools of the country. The study, based on returns from 715 public high schools, covered the school year 1947-1948. The randomly selected sample of schools was proportionate to the types and sizes of the schools in the entire country. In 1952, Martin published a similar study, which was restricted to biology, based on returns from 786 public high schools, for the school year 1949-1950.

The Committee on Educational Trends of the Kansas Academy of Science has issued two reports. The first, Alm (1938), was based on a proportionate sample of 233 High-school Principal's Organization Reports for the year 1936-1937, and a sample of 1929-1930 reports from 70 schools in second-class cities. The second Academy report, Reed (1951), was based on questionnaires received from a proportionate sample of 100 schools of various sizes.

Lessig (1942) presented, in a master's thesis, data from more than 200 questionnaires completed by Kansas biology teachers. In this study the schools were classified both as to type of organization and as to enrollment. The Lessig study was patterned after the national biology teaching survey conducted by Riddle (1942).

Ridgway (1931), in his study of the training and teaching combinations of Kansas high-school teachers, included a table showing the non-science subjects taught by science teachers. Mathematics was taught by 24% of all science teachers; 15% taught science, only. A similar study by Irwin (1938) showed that 34% of the science teachers taught only science, while 35% taught science and mathematics.

Lockard (1946) found that 48% of the Kansas science teachers taught only science, a 14% increase over Irwin's (1938) study. Lockard found mathematics and science still the most frequent combination. In an unpublished extension of this study, Lockard tabulated the individual sciences taught in 140 high schools, selected to give a proportionate sample.

Wilson (1951) made a survey in which he included data, from 570 Nebraska high schools with an enrollment of 64,342 for 1949-1950, pertaining to offerings and enrollments in the high-school sciences.

Perry (1953) made a comparison of science offerings in class "A" Kansas high schools with offerings in the other high schools of the state. Breukelman and Andrews (1953) examined High-school Principal's Organization reports of 654 accredited senior high schools and 25 junior high schools in Kansas and presented data on offerings and enrollments in the sciences in these schools. Nellans (1954) studied, on the basis of questionnaire returns, the laboratory aspect of science instruction in Kansas high schools with enrollments of less than 50 students.

Methods

This study was based on data found in the 1954 High-school Principal's Organization Reports on file at the State Department of Public Instruction.

For each school, the items recorded and tabulated were as follows: total school enrollment, enrollment in each section of each science taught, non-science subjects taught by each science teacher.

The schools were divided into population classes corresponding to

those used in the study of science teaching in the public high schools in the United States (Johnson, 1950).

Junior high schools were included in the tabulations if the report showed that 9th-grade science was taught. Seventh-grade and 8th-grade science courses were not included.

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Results

For the school year 1954-1955, 650 senior high schools and 57 junior high schools were accredited by the State Department of Public Instruc-

TABLE I.—Number of schools in each size group and the number of science courses offered by the schools.

Size of school (number of pupils)	Number of schools	Per cent	Number of schools offering from one to four or more science courses:				
			None	1	2	3	4 or more
10–24	42	6.1	2	24	12	4	0
25–49	163	23.8	10	53	74	23	3
50–74	140	20.5	2	28	69	36	5
75–99	75	10.9	0	8	33	28	6
100–199	132	19.2	0	7	30	67	32
200–299	43	6.2	0	6*	4	15	23
300–499	29	4.2	0	2*	4	10	13
500–999	51	7.4	0	19*	2	6	23
1,000–2,499	10	1.4	0	2*	1	0	7
2,500–	2	.3	0	0	0	0	2
Totals	687		14	149	229	189	114

Read table thus: Reports were examined from 42 schools with enrollment from 10-24; this 42 constitutes 6.1% of the 687 reports examined; of the 42, two offered no science in 1954-55, 24 offered one science course, 12 offered two, 4 offered three, and none offered three, and none offered 4 or more.

* These were separately accredited junior high schools which offered ninth grade general science, but no other science.

tion in Kansas. The present study included data from 650 (100%) of the accredited senior high schools and 37 (65%) of the junior high schools. The non-accredited senior high schools were not included, because their reports had not been received at the time of tabulating the data or because the reports were incomplete. Junior high schools with 9th grade science were included in this study because the 9th grade is usually included in the senior high school in Kansas. In 563 of the 650 high schools accredited for 1954-1955, the senior high school consisted of grades 9-12, with general science predominantly a ninth grade subject.

SCIENCES IN THE SCHOOLS OF VARIOUS SIZES

Fourteen Kansas high schools offered no science at all in 1954-1955, whereas 140 offered one science, 229 offered two, 189 offered three, and 114 offered four or more sciences. Table I shows the number of schools in each size group and the number of sciences offered by the schools.

It should be noted that almost 60% of all Kansas high schools had enrollments of less than 100. Breukelman and Andrews (1953) showed that in 1951 about 62% of the schools had enrollments of less than 100. In general, the number of schools in each size group in the present study is about the same as in 1951. However, the 500-999 size group increased from 32 in 1951 to 51 in 1954.

The table also shows that the larger schools in general offered more science courses. The schools with 300 or more students which offered only one science course were nearly all junior high schools. In most cases, these offered general science in either the 8th or 9 th grade.

Several small schools are shown as teaching no science at all. Other small schools may alternate science with some other course so that science appears in the High-school Principal's Organization Report in alternate years, only. In many of the smaller schools, certain science courses are alternated. For example, a number of schools offer general science one year and biology the next. Other common alternations are biology and physics, and physics and chemistry. Table I shows only courses reported as taught in 1954-1955.

It will be noted that the number of science courses offered increased regularly with school size. Of the schools offering only one or two science courses, about 70% had enrollments of less than 75 while all except 14 of the schools offering four or more science courses had 75 or more.

SCHOOLS OFFERING DIFFERENT SCIENCES

The four most frequently offered sciences were general science, biology, chemistry, and physics. Table II shows the number of schools of each size group offering these sciences.

In all the schools studied, 74% offered general science, 73% offered biology, 31% offered chemistry, and 39% offered physics. Examination of Table II reveals that chemistry and physics were offered more frequently

TABLE II. Number of schools offering the four main sciences.

Size of school	Number of schools	General science		Biology		Chemistry		Physics	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
10–24	42	23	55	22	53	4	10	4	10
25–49	163	98	60	96	59	12	7	31	19
50–74	140	108	77	103	73	18	13	38	27
75–99	75	62	83	59	79	17	23	34	45
100–199	132	116	88	112	85	73	56	69	52
200–299	43	37	86	38	89	37	75	32	75
300–499	29	17	59	28	97	20	69	21	73
500–999	51	40	78	32	63	29	57	28	55
1,000–2,499	10	5	50	8	80	7	70	6	60
2,500–	2	1	50	2	100	2	100	2	100
Totals	687	507	74	500	73	219	31	265	39

Read table thus: In schools from 10-24 enrollment: there were 42 such schools; 23, or 55% of these offered general science; 22, or 53% of these offered biology, etc.

in schools with enrollments of 100 and above. General science and biology, on the other hand, were offered with more nearly the same frequencies in all sized schools.

Table III shows how the results of the present study compare with those of the Reed (1951) study, based on data for the school year 1949-

TABLE III. Comparison of present study with the 1953 study, Reed (1951), Johnson (1950), and Wilson (1951) studies, as regards percentage of schools offering the four main sciences. The numbers in parentheses were calculated (see text).

	Present Study	1953 Study	Reed	Johnson	Wilson
General science	74	84	92 (82)	77	73
Biology	73	71	90 (74)	85	67
Chemistry	31	31	48 (33)	49	21
Physics	39	34	76 (53)	48	38

1950, the Johnson (1950) study, based on data for 1947-1948, the Wilson (1951) study, based on data for 1949-1950, and the Breukelman and Andrews (1953) study, based on 1951-1952 data. [Hereafter the Breukelman and Andrews (1953) study is referred to as the 1953 study.]

Two numbers are shown for the Reed study. The first of these numbers is the percentage of schools reporting the science as "offered." Schools were included in this number if a science course was offered at all. The numbers in parentheses were obtained as follows: 92% of the schools reported offerings in general science, but only 72% offered it every year; the other 20% offered it in alternate years. For any given year the total percentage offering general science would be 72% plus half of 20%, or 82%. This figure is near the 84% of the 1953 study, but is 8% higher than the present study. The present study showed a 10% decrease in the General Science offerings in the high schools since 1953. This is due to the fact that many larger school systems are, now, offering general science in the 7th or 8th grade instead of the 9th. The percentage of schools offering biology and chemistry are about the same in the Reed study, 1953 study, and the present study. There is a discrepancy in the case of physics, where the 53% reported by Reed is well above the 34% offered in the year 1951-1952 and the 39% in 1954-1955. In 1954-1955 the percentage of schools in Kansas offering physics increased 5% above the 1951 offerings.

Since the Reed study was based on a sample of 100 returns out of 647 questionnaires, there is a possibility that the schools having better science programs were the ones which returned the questionnaire dealing with the science teaching. It is possible that the schools with poorer science offerings did not return the questionnaire.

For biology, the Martin (1952) study reported 809, or 95% of the 851 schools responding, as offering the subject. Of these, 729, or 86% of the total, offered biology each year, the other 80 teaching it in alternate years. These figures are somewhat higher than those of Johnson (1950) and much higher than the 71% shown by the 1953 study and the 73% shown by the present study.

SCIENCES OTHER THAN GENERAL SCIENCE, BIOLOGY, CHEMISTRY, AND PHYSICS

A variety of sciences other than the main four were offered in 1954-1955. Some of these were advanced offerings, while others represented special fields. Table IV shows the frequencies of these sciences in the various sized schools. A total of 178 schools, 26% of the 687 tabulated, offered courses in sciences other than the four main ones.

When these sciences are arranged into four broad groups, general science, biological science, physical science and other sciences, we note that 24 schools offered courses in general sciences (senior science, practical science), 23 in physical science (physical geography, aeronautics,

TABLE IV. Schools offering science courses other than general science, biology, chemistry, and physics.

Size of School	Agriculture	Physiology	Physical geography	Aeronautics	Health	Photography	Physical science	Senior science	Practical science	Botany	Electricity	Other science
10–24	4	1	0	0	1	0	0	1	0	0	0	0
25–49	15	10	4	0	3	0	0	4	1	0	0	3
50–74	7	5	1	0	4	1	0	2	0	0	0	2
75–99	3	1	0	0	4	0	0	3	1	0	0	0
100–199	4	4	2	0	4	1	1	0	1	0	0	6
200–299	0	4	1	1	2	0	0	0	3	0	2	3
300–499	3	3	0	1	0	0	0	1	1	0	0	2
500–999	0	4	0	0	0	0	0	1	0	3	1	11
1,000–2,499	1	5	0	2	0	0	2	1	2	2	2	4
2,500–	0	1	0	1	0	0	0	0	1	1	0	1
Totals	37	38	8	5	18	2	3	13	10	6	5	32

photography, physical science, electricity), 99 in biological science (agriculture, physiology, health, botany), and 32 in other sciences (laboratory science, industrial science, civic science, etc.) These figures differ markedly from those of the Johnson study, which included, out of 715 high schools studied, 49 courses of the general type, 61 in the physical sciences, and only 25 in the biological sciences. The difference is accounted for, in part, by the much higher percentage of large schools in the Johnson study, and, in part, by the relatively higher frequency of physiology and agriculture in Kansas.

ENROLLMENT IN SCIENCE COURSES

More students were enrolled in biology than in any other science, although this was not true of all sized schools. In the schools, of less than 100 students, general science had the largest enrollment, followed in order by biology, physics, and chemistry (Table V). In schools with enrollments above 100 more students were enrolled in chemistry than in physics, and 1.5 times more students were enrolled in biology than in general science.

The true totals were slightly larger than those shown, because a few principals neglected to report their class enrollments. The numbers in-

TABLE V. Total enrollments in the four main sciences in the 687 schools.

Size of School	General science	Biology	Chemistry	Physics
10–24	149	176	21	13
25–49	1,231	1,150	98	259
50–74	1,874	1,546	174	370
75–99	1,227	1,215	228	358
100–199	3,035	3,325	1,098	786
200–299	1,236	1,756	625	469
300–499	764	2,184	575	426
500–999	3,741	4,270	1,357	672
1,000–2,499	1,214	2,315	689	453
2,500–	301	1,313	359	347
Totals	14,772	19,250	5,224	4,153

volved were small, however. The totals shown for each science were probably within 100 of the actual enrollments.

Enrollments in general science in schools with enrollments from 300-499 decreased from 2,029 in the 1953 study to 764 in the present study. This was due, in a large extent, to schools of this size group offering general science in the 7th and 8th grade in 1954-1955, instead of in the 9th grade as they did in 1951-1952. In 1951-1952, general science was not offered in schools with more than 2500 enrollment, whereas 301 such enrollments in general science were recorded in 1954-1955. Apparently, the larger schools have increased the offerings in the science curriculum as enrollment has increased in the school.

Table VI shows the average enrollment in each of the four main sciences in the present study, the 1953 study, the Reed study, and the Johnson study. It will be noted that Reed's figures are much higher than those of both the 1953 study and the present study, probably indicating more returns from the schools with the better science programs. The higher figures of the Johnson study reflect the higher percentage of larger schools used in his study. In the Johnson study, 64% of the schools had enrollments of 100 or more and only 36% were below 100; only 40% of the Kansas schools had enrollments of 100 or more, while almost 60% were below 100.

TABLE VI. Average number of students per school offering the 4 main sciences.

	Present Study			1953 Study			Reed Study			Johnson Study		
	Schools Offering	Students Enrolled	Average Per School	Offering Schools	Students Enrolled	Average Per School	Schools Offering	Students Enrolled	Average Per School	Schools Offering	Students Enrolled	Average Per School
General Science	507	14,772	29	569	14,973	26	82	2,356	29	552	30,153	58
Biology	500	19,250	39	482	15,130	31	74	3,192	43	531	32,104	60
Chemistry	214	5,224	24	208	4,555	22	33	1,315	40	308	14,178	44
Physics	265	4,153	16	232	3,400	15	53	1,295	25	298	9,036	30

In Kansas, general science is most often taught in the 9th grade, biology in the 10th, chemistry and physics in the 11th and 12th. However, the data gathered during the present study indicated that many of the medium-sized and large-sized high schools since 1951 have begun to offer general science in the 8th grade and sometimes the 7th grade instead of in the 9th grade as they did previously. The 1954-1955 compilations of total grade enrollments were not available at the time of this writing, but the 1953-1954 figures were as follows: ninth grade, 26,892; tenth grade, 25,017, eleventh grade, 21,770; twelfth grade, 19,852. The evidence is that the total 1954-1955 figures are about 2500 higher. However, taking the 1953-1954 total enrollments as the basis, the 14,772 pupils in general science represent about 55% of the total enrollment of 26,892 in the ninth grade. The corresponding figure for biology is about 77%. For chemistry and physics, which are offered about equally in the 11th and 12th grades, the total enrollment of 9,377 in the two sciences represents about 23% of the 41,622 pupils enrolled in the two grades.

In biology, Martin (1952) reported that in the 10th grade, where biology is most often taught, 76% of the total enrollment of this grade were enrolled in biology. This is in close agreement with the findings in the present study.

The Reed report did not include the total enrollments in each science and the averages he gave were obtained by averaging averages; they are not comparable, therefore, to the averages of either the present study or the Johnson study given in Table VI. For the Reed section of Table VI, the

TABLE VII. Data, showing average enrollments, taken from Tables II, III, IV, and V of the Reed (1951) study.

Average number enrolled in:	Group I n=66	Group II n=22	Group III n=8	Group IV n=4
General science	14.9	22.8	77.0	62.5
Biology	15.8	32.2	82.0	196.8
Chemistry	9.1	14.0	27.1	47.6
Physics	9.9	11.5	24.0	49.0

averages were obtained by calculation from data presented in Table VII of this study, which was compiled from Tables II, III, IV, and V of Reed's report. For example, in general science in group I the number of pupils enrolled is $66\times14.9=990$; in group II, $22\times22.8=500$; in group III, $8\times77=616$; in group IV, $4\times62.5=250$; a total of 2,356 enrolled in the 82 schools offering the subject, or an average per school of 29. This is the

figure that appears in the general science section of Reed's study in Table VI.

Averages in Nebraska shown by the Wilson (1951) study are almost identical with those of our 1953 study. However, when his averages are compared to those of the present study, general science, biology and chemistry are 3%, 8% and 3% lower, respectively. For physics his average is 3% higher (Table VI). In Nebraska 10,608 students were enrolled in general science, 12,028 in biology, 2,552 in chemistry, and 4,115 in physics. The average enrollments, per school offering the science, were 26, 31, 21, and 19, respectively.

CLASS SIZES

In general, class sizes increased fairly regularly with school size, from 6 to 36 in general science, from 7 to 31 in biology, from 4 to 28 in chemistry, and from 3 to 28 in physics (Table VIII).

For any one school size with less than 1000 enrollment, the classes in general science and biology were larger than those in chemistry and physics; in schools above 1000 enrollment the classes in all four sciences were about the same. This is due in part, to the usual placement of general science and biology in the 9th and 10th grades and the physical sciences in the 11th and 12th, together with the fact that general science and biology are often required while the physical sciences are usually elective. Almost twice as many sections of general science were offered in the schools with less than 200 enrollment as were offered in schools with more than 200. The number of sections of biology was about the same in schools below 200 as it was in those above this number. Chemistry sections, on the other hand, were offered more frequently in schools above 200. Physics sections were offered more frequently in schools below 200. It should be noted that almost twice as many sections in physics and in chemistry were offered in the schools of 100-199 enrollments as were offered in any one other size group of schools. For general science and biology, the greatest number of sections were offered in size groups 100-199, 500-999, and 50-74, respectively.

FULL-TIME AND PART-TIME TEACHERS

A full-time science teacher is here defined as one who teaches four or more science classes daily, a part-time science teacher as one who teaches three or less. There were many more part-time (815) than full-time (62) teachers in the schools with enrollments of 500 or less; even in the largest schools there were 10 part-time science teachers. Table IX shows the number of pupils of full-time science teachers and of part-time science teachers.

It should be noted that while the full-time teachers had more science students per teacher, there were so many more part-time science teachers in the state that the majority of science students in schools of small and

TABLE VIII. Number of sections and class sizes in general science, biology, chemistry, and physics.

Size of School	General science			Biology			Chemistry			Physics		
	No. of sections	Median size	Range	No. of sections	Median size	Range	No. of sections	Median size	Range	No. of sections	Median size	Range
10–24	23	6	2–12	33	7.5	2–13	4	4.5	2–10	4	3	2–5
25–49	102	12	3–26	99	11	3–24	12	6	5–24	31	7	2–20
50–74	115	16.5	5–32	106	15	4–31	18	10	3–14	38	10	3–17
75–99	64	20	5–31	66	18	3–36	20	11	5–18	34	10	2–24
100–199	140	22	5–44	164	19	4–39	79	13.5	4–31	70	11	2–23
200–299	52	25	10–36	74	24	10–48	37	17.5	8–31	33	13	3–26
300–499	28	28	8–41	89	25	15–34	31	18	10–27	27	18	5–22
500–999	135	28	10–47	155	28	11–41	67	20	5–32	38	19	5–35
1,000–2,499	35	36	19–43	80	27	13–49	24	28	18–40	18	27	11–34
2,500–	11	26	22–33	42	31	28–35	13	28	24–31	13	28	17–23
Totals	705			898			305			306		

Read table thus: In schools of 10–24 enrollment, there were 23 sections of general science, with a median enrollment of 6, the largest general science class had 12 and the smallest had 2 students; etc.

medium enrollments were taught by part-time science teachers. The average number of pupils per full-time science teacher increased steadily,

TABLE IX. The number of pupils of full-time (one who teaches four or more sections) science teachers as compared to the number of part-time science teachers.

Size of School	Full-time teachers		teachers Part-time		Average number of science pupils per science teacher	
	Number	Percent	Number	Percent	Full-time	Part-time
10–24	0	0	48	100	0	8
25–49	1	1	203	99	36	15
50–74	3	2	192	98	59	19
75–99	4	4	105	96	68	27
100–199	47	23	161	77	72	32
200–299	19	22	63	78	89	41
300–499	23	35	43	65	96	38
500–999	65	55	52	45	125	45
1,000–2,499	38	81	9	19	148	54
2,500–	19	95	1	5	138	71
	291	20	877	80		

Read table thus: In schools of 50–74 enrollment, there were 195 science teachers; 3 or 2% of these taught four or more classes in science, while 192 or 98% taught other subjects in addition to science. The average number taught daily by the 3 full-time science teachers was 59, the number of science students taught by the 192 part-time science teachers was 19.

ranging from 36 to 148, whereas the number of students per part-time science teacher increased more slowly, ranging from 8 to 71, only.

Of the 1096 science teachers shown in Table IX, 219 or about 20% were full-time science teachers, whereas 877 or 80% were part-time.

COURSES TAUGHT BY SCIENCE TEACHERS

In the small schools where only one or two science courses were offered, the teacher who was in charge of the science taught from two to four or more other classes. Sometimes these other classes were subject

matter fields that were not closely related to each other or to the sciences, but certain trends and patterns were present. Some of these have been the

TABLE X. Non-science courses taught by general science teachers.

Size of School	None	Math	Algebra	Geometry	Industrial arts	Woodwork, shop	Physical Education	Athletics	History	Constitution	Citizenship	Music, band	Food, clothing	Library	Foreign language	Journalism, speech, English	Manual training	Driver training	Others
10–24	1	9	7	2	0	3	12	2	5	2	2	1	2	1	2	2	0	1	5
25–49	8	13	22	12	7	13	31	6	11	6	1	2	13	2	3	11	0	2	27
50–74	12	14	21	14	8	6	23	7	12	5	1	5	22	6	2	10	0	5	19
75–99	4	14	13	9	5	5	17	7	2	3	0	1	5	2	2	0	0	3	14
100–199	36	16	21	17	3	3	20	7	6	4	0	3	6	4	0	1	2	3	17
200–299	13	7	4	1	1	0	9	4	5	1	1	0	0	0	0	2	0	4	3
300–499	6	3	3	0	0	0	4	0	0	0	0	0	0	1	0	0	0	0	2
500–999	40	4	3	1	1	0	1	1	1	0	0	0	1	1	0	0	0	1	4
1,000–2,499	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,500–	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	133	80	94	56	25	30	117	34	42	21	5	12	49	17	9	26	2	19	91

TABLE XI. Non-science courses taught by biology teachers.

Size of School	None	Math	Algebra	Geometry	Industrial arts	Woodwork, shop	Physical Education	Athletics	History	Constitution	Citizenship	Music, band	Food, clothing	Library	Foreign language	Journalism, speech, English	Manual training	Driver training	Others
10–24	2	1	3	0	4	2	8	3	2	2	1	5	3	1	0	5	0	0	8
25–49	5	10	13	7	8	11	43	2	12	7	4	4	15	1	2	10	2	5	28
50–74	7	6	12	9	4	7	24	6	12	10	2	7	30	9	2	18	0	3	19
75–99	5	13	12	6	4	5	18	8	7	3	0	1	6	2	2	3	0	4	9
100–199	36	5	12	4	1	1	16	11	10	3	0	1	2	4	1	7	2	9	20
200–299	20	3	1	0	0	0	9	2	2	3	0	0	0	0	0	1	0	2	3
300–499	18	1	1	0	0	0	3	3	2	2	1	0	0	0	1	0	0	1	4
500–999	26	3	3	0	0	0	1	2	2	0	0	0	0	2	0	1	0	1	8
1,000–2,499	17	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4
2,500–	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	147	42	57	26	21	26	123	37	49	30	8	18	56	19	8	45	4	25	103

TABLE XII. Non-science courses taught by chemistry teachers.

Size of School	None	Math	Algebra	Geometry	Industrial arts	Woodwork, shop	Physical Education	Athletics	History	Constitution	Citizenship	Music, band	Food, clothing	Library	Foreign language	Journalism, speech, English	Manual training	Driver training	Others
10–24	0	2	1	0	0	2	1	0	0	0	0	0	1	0	0	1	0	0	0
25–49	1	2	1	2	1	1	2	0	0	0	0	0	3	1	1	2	0	0	4
50–74	4	3	6	4	0	0	1	1	1	0	0	0	5	0	0	0	0	2	1
75–99	2	6	3	6	0	0	2	2	0	0	0	0	2	1	0	0	0	2	0
100–199	31	10	37	8	0	0	4	2	2	0	0	0	3	3	0	4	0	5	12
200–299	18	5	5	3	0	0	1	1	0	0	0	0	1	0	0	1	0	1	1
300–499	11	2	53	0	1	1	2	0	0	0	0	0	0	2	0	0	0	1	2
500–999	21	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
1,000–2,499	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,500–	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	99	35	110	25	2	4	13	6	3	0	0	0	15	7	1	8	0	11	24

TABLE XIII. Non-science courses taught by physics teachers.

Size of School	None	Math	Algebra	Geometry	Industrial arts	Woodwork, shop	Physical Education	Athletics	History	Constitution	Citizenship	Music, band	Food, clothing	Library	Foreign language	Journalism, speech, English	Manual training	Driver training	Others
10–24	1	2	1	1	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0
25–49	2	4	12	7	2	1	6	6	3	4	1	0	3	0	1	2	0	0	7
50–74	3	12	18	12	2	2	4	2	1	0	0	0	0	3	0	0	0	1	4
75–99	4	9	13	8	1	3	9	2	1	1	0	0	1	1	0	0	0	3	1
100–199	30	10	15	13	3	1	3	5	1	0	0	0	1	1	0	0	1	4	7
200–299	14	8	7	5	1	0	0	0	0	0	0	0	0	0	0	0	0	2	4
300–499	11	3	3	1	0	1	2	0	0	0	0	0	0	3	0	0	0	1	2
500–999	17	3	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1,000–2,499	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,500–	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	93	52	73	49	10	8	24	15	8	5	1	0	5	8	2	3	1	11	28

subjects of previous studies: Irwin (1938), Ridgway (1931), Lockard (1946), Reed (1951), and Breukelman and Andrews (1953). In most previous studies, no distinction was made between one science and another.

Table X shows the non-science courses taught by general science teachers. Non-science courses in the fields of mathematics, physical education, home economics, and social science, in descending order, were most frequently taught by general science teachers. They taught 117 courses in physical education, 94 in algebra, 80 in general mathematics, 56 in geometry, 49 in food and clothing, and 42 in history. There were 91 other unidentified non-science courses taught by general science teachers, also.

Similar trends are evident in Table XI which presents the data for biology teachers. Non-science courses in descending order of frequency with which they were taught by biology teachers were: physical education 123, algebra 57, food and clothing 56, history 49, general mathematics 42, and geometry 26. In addition to these fields, 45 courses in journalism, speech and English and 103 unidentified non-science courses were taught by biology teachers.

The main difference in the chemistry data, Table XII, was in the smaller number of non-science courses taught. The difference reflects the higher proportion of full-time teachers of chemistry in the larger schools. The non-science courses in descending order of frequency with which they were taught by chemistry teachers were: algebra 110, general mathematics 35, geometry 25, food and clothing 15, and physical education 13. In addition, 24 unidentified non-science courses were taught by chemistry teachers.

The pattern for physics teachers was somewhat intermediate (Table XIII) between those of biology and chemistry. The non-science courses in descending order of frequency with which they were taught by physics teachers were: algebra 73, general mathematics 52, geometry 49, physical education 24. Also, 28 unidentified non-science courses were taught by physics teachers.

Trends

NUMBER OF SCIENCE TEACHERS

Table XIV shows the number of science teachers as reported by Ridgway (1931), Irwin (1938), Lockard (1946), the 1953 study, and the present study. Ridgway (1931) reported that 1,080 different individuals were teaching science courses in 1930-1931. The data in the table show that the number of science teachers decreased steadily until after World War II. By 1951, there were 929 science teachers (Breukelman and Andrews, 1953), which was about the same number that was teaching during the depression (Irwin, 1938). In the present study, 1,096

science teachers were reported. This is the greatest numbr of science teachers ever rcorded for Kansas, but the number of science teachers has not kept pace with the increase in science class offerings.

Ridgway (1931) reported the 1,080 science teachers as teaching 1,695 science classes, or 1.6 classes each. The total number of classes was not listed by Irwin or Lockard. In 1951-1952, the 929 science teachers

TABLE XIV. Number of teachers teaching science and teaching science only.

	Ridgway 1930-1931	Irwin 1927-1938	Lockard 1945-1946	1953 study	Present study 1954-1955
Number of teachers teaching science	1,080	919	792	929	1,096
Number of teachers teaching science only	110	209	169	177*	219
Per cent teaching science only	10	23	21	19	20

* This figure is not exactly comparable, because it is the number of full-time science teachers (a teacher who teaches four sections of science). Thus a teacher might be teaching three classes in science and not appear in this figure; he would, however, have been counted in the other reports. Again, a teacher who has four science classes and one non-science class would not be counted in the other reports, but would be included in our 177 in the 1953 study and in our 219 in the present study.

taught 2,371 science classes, or 2.6 classes each. Thus, while the number of different individuals teaching science decreased slightly, the total number of science classes was increasing by 676, or about 40%.

In this study, the 1,096 science teachers taught 2,437 science classes, or 2.2 classes each. These data seem to indicate that the number of science teachers in reference to the number of science classes taught by them has increased since 1951. This increase is due, in part, to the fact that two science teachers are teaching the general science and general biology courses, whereas one science teacher could be teaching both courses if he were not teaching so many non-science courses. The problem is not as serious as it might seem. The number of full-time science teachers increased from 177 in 1951 to 219 in 1954.

SCIENCES TAUGHT

The only data available for a comparison of the individual sciences were from an unpublished research paper by Lockard, who in 1946 studied 140 schools, selected to be a proportionate sample of Class A, Class B, and Class C high schools in Kansas. Tables XV and XVI show

the comparison among Lockard's data, those of the 1953 study, and those of the present study.

The data in Table XV show offerings in 1945-1946, 1951-1952 and 1954-1955 school years, respectively. The percentage of schools offering general science increased until 1951; since that time, a 10% decrease has

TABLE XV. Number of schools offering the four main sciences. Numbers in parentheses indicate schools sampled.

	General science	Biology	Chemistry	Physics
Lockard study (140)	103	71	30	65
Per cent	74	65	21	46
1953 study (679)	569	482	208	232
Per cent	83	71	31	34
Present study (687)	507	500	214	265
Per cent	74	73	31	39

occured. This is due to the fact that many schools have moved general science from the 9th to the 8th grade. General science offered in the 8th grade is not included.

Biology has shown a steady increase, both in number and per cent, whereas, chemistry offerings have remained about the same since 1951. From 1946 to 1951 the chemistry offerings increased 10%. Physics offerings decreased 12% from 1946 to 1951, but increased 5% between 1951 and 1954.

Table XVI shows somewhat the same trends as Table XV, in terms of the total number of classes taught. While these data are spread over too short a duration to mean much, they do agree, in general, with national trends in relative decrease in enrollments and offerings in specialized sciences and an increase in the more general sciences. It should be pointed out that Table XVI shows that the number of classes per school in both physics and chemistry showed a 5% increase from 1951 to 1954; that general science showed a 7% decrease, and that biology remained the same.

The trends as revealed by the Ridgway, Irwin, Lockard studies are in general agreement with those of the ten years from 1940 to 1950, as shown by the Reed report, although the actual figures are not comparable in most instances. For example, the schools offering general science

TABLE XVI. The total number of classes offered in the four main sciences in the Lockard and the present study. Numbers in parentheses indicate schools sampled.

	General science	Biology	Chemistry	Physics
Lockard (140)	132	137	48	77
Classes per school	.94	.98	.34	.55
1953 study (679)	754	892	265	266
Classes per school	1.11	1.31	.39	.39
Present study (687)	705	898	305	306
Classes per school	1.03	1.31	.44	.44

changed from 86% in 1940 to 92% in 1950; biology changed from 70% to 90%; chemistry from 36% to 48%; and physics from 73% to 76%.

NUMBER OF STUDENTS ENROLLED

Since the Alm (1938) report was based on the High-school Principal's Organization Reports, it may be compared directly with the present study. Table XVII shows the number of students enrolled in the

TABLE XVII. Total number and percentage of students enrolled in general science, biology, chemistry, and physics.

	General science	Biology	Chemistry	Physics
Alm (1938) enrollment	12,478*	12,718	3,856	6,414
Per cent of total	15.9	13.3	4.0	6.7
1953 study enrollment	14,973	15,130	4,555	3,400
Per cent of total	15.0	15.0	4.5	3.4
Present study enrollment	14,772	19,250	5,224	4,153
Per cent of total	12.5	16.3	4.4	3.5

* Ninth grade not counted in total enrollment of 15 schools in the first class.

four main sciences in 1936-1937, 1951-1952, and 1954-1955.

It may be noted for comparison that in Nebraska Wilson (1951) found that of the total enrollment in the high schools studied, 16.49% were taking general science, 18.69% were taking biology, 3.97% were taking chemistry, and 6.40% were taking physics.

The Alm report included a comparison of average enrollments per school in 1929-1930 and 1936-1937. Although the report was based only on schools in second-class cities, the trends were consistent with those observed in other studies. Table XVIII shows the comparison.

For biology some comparisons may be made between the results of the present study and the 1941-1942 study made by Lessig. In 187 schools, with an enrollment of 54,938, there were 11,108 or 20.1% en-

TABLE XVIII. Total enrollment and average enrollment in the four main sciences in 70 schools in cities of the second class (Alm, 1938).

	General science	Biology	Chemistry	Physics
1929-1930 Total enrollment	1,323	2,567	1,054	1,905
Average enrollment for school offering the science	34	50	33	30
1936-1937 Total enrollment	2,653	4,146	1,474	1,655
Average enrollment for school offering the science	53	67	36	28

rolled in biology. Biology was offered by 478 schools in Kansas, and was taught by 509 teachers. In the 1953 study, 15,130 or about 15%, of the total high-school enrollment of about 101,000 were enrolled in biology. Biology was offered in 482 high schools and was taught by 521 teachers. In the present study 19, 250, or about 16.5% of the total high school enrollment of about 116,000 were enrolled in biology. The decrease from 20% in the Lessig study to 15% in the 1953 study and to 16.5% in the present study may have been more apparent than real, since the Lessig study was based on questionnaires returned by about 42% of the biology teachers to whom questionnaires were sent.

Comparable data were available for Nebraska. Wilson (1951) presented a comparison of the number and per cent of students enrolled in the four main sciences for 1929-1930, 1939-1940, and 1949-1950. Table

XIX, which is a part of Table 50, page 136, of the Wilson study, shows the trends.

In 1948, the State Department of Public Instruction sponsored the establishment of a Workshop in Science Education at the Kansas State Teachers College of Emporia. From 1948 to 1953, this workshop gave much of its attention to the production of a guide (*Laboratory Science*

TABLE XIX. Enrollment trends in the four main sciences (Wilson, 1951).

Course	1929-1930		1939-1940		1949-1950	
	Total enrollment	Per-cent	Total enrollment	Per-cent	Total enrollment	Per-cent
General science	8,807	15.50	11,281	13.62	10,608	16.49
Biology	5,938	10.45	11,795	14.24	12,028	18.69
Chemistry	2,053	3.61	3,054	3.69	2,252	3.97
Physics	6,035	10.62	5,901	7.13	4,115	6.40

TABLE XX. Per cent of pupils enrolled in sciences from 1890 to 1947. (Taken from page 6 of the Johnson, 1950, study).

Year Reported	Ninth grade General science	Biology	Chemistry	Physics
1890			10.10	22.21
1895			9.15	22.77
1900			7.72	19.04
1905			6.76	15.66
1910			6.89	14.61
1915		6.90	7.38	14.23
1922	18.27	8.78	7.40	8.93
1928	17.50	13.58	7.07	6.85
1934	17.75	14.60	7.56	6.27
1947	18.32	19.51	8.62	5.49

Handbook, State Department of Public Instruction, 1954) for a laboratory science course to follow 9th grade general science and to give laboratory experiences to pupils who were not interested in the more specific sciences. It was hoped that this would lead to the establishment of an additional science course, thus beginning a new trend in Kansas science. Not many schools listed such a course in 1954; however, it may become more popular in the future. It is too early to evaluate the trend, but it should be noted that the number of offerings in what appears to be senior laboratory science and similar courses increased from 10 in 1951 to 23 in 1954.

Although the foregoing trends differ in detail, they seem to point toward the conclusion that general science and biology are increasing and that the physical sciences have either undergone a decrease in emphasis or are holding their own. This agrees with the long range national trends as reported in the Johnson (1950) study. Table XX is Table V of the Johnson study.

OUR DATA FOR 1951-1952 AND 1954-1955 COMPARED

The data compiled by us for the 1954-1955 school year (the present study) are comparable to the data we compiled for the 1951-1952 school year (the 1953 study). In general, the results of the two studies do not differ greatly. However, some obvious differences exist—differences, which may not indicate trends, but do indicate changes that have occurred in the last 3 years.

The total number of schools offering from 1 to 4 or more science courses increased from 1951 to 1954. The number of schools offering none, 1, 2, 3, and 4 or more science courses in 1951 as compared to 1954 were: no science (11 in 1951 and 14 in 1954); 1 science (133 and 140); 2 sciences (230 and 229); 3 sciences (194 and 189); and 4 or more sciences (110 and 114). There were no major differences in the number of science courses offered by schools, and the size groups changed only slightly from 1951 to 1954.

In 1951, a total of 569 schools offered general science, 482 offered biology, 208 offered chemistry, and 232 offered physics; whereas 507, 500, 214, and 265, respectively, offered the 4 main sciences in 1954. General science was the only science to show a loss. Actually the number of general science offerings increased; but, since a large number of schools moved general science from the 9th grade to the 7th or 8th grade, the increase was not evident in this study. Both the number and per cent of schools offering biology increased or remained about the same in all except the 500-999 size group where a decrease of 26% was recorded. This percentage decrease was caused by an increase in the number of junior high schools, which did not offer biology, in this size group. About 19% more schools offered biology in size group 300-499, and 20% more in size group 1,000-2,499. Although 6 more schools offered chemistry in

1954 than in 1951, the number of schools offering chemistry in any particular size group remained about the same, except in size group 300-499 where a 12% decrease was recorded. The number of schools offering physics in each size group remained about the same or increased. The greatest increases were in small to medium sized schools.

There were some interesting changes in the number of schools offering science courses other than the main 4. In 1951, senior science, practical science, botany, and electricity were offered by 7, 3, 3, and 3 schools, respectively; whereas, in 1954 they were offered by, 13, 10, 6, and 5 schools. These increases, in general, occurred in the larger schools, although, increased offerings in a senior science occurred in schools with less than 100 enrollment.

Both agriculture and physiology offerings decreased in nearly all of the schools with an enrollment of less than 300. Agriculture was offered by 49 schools in 1951 and by 37 in 1954; physiology was offered by 51 schools in 1951 and by 38 in 1954. Other unidentified, science courses, which were offered in 1951 were not recorded. But, in 1954, there were 32 unidentified science courses taught, for the most part, in schools with an enrollment of more than 100.

The total enrollment in general science in the secondary schools decreased 201 (Table XXI). Again, this decrease was caused by schools teaching general science in the 7th or 8th grade rather than in the 9th

TABLE XXI. Enrollments in 4 main sciences in 1951 and 1954.

	General science	Biology	Chemistry	Physics
1951	**14,973**	15,130	4,555	3,400
1954	**14,772**	19,250	5,224	4,153
Net gain or loss	**loss 201**	gain 4,120	gain 669	gain 753

grade. Biology, chemistry, and physics each showed a gain in total enrollment, however, enrollment did not increase in all size groups of schools.

General science decreased or remained about the same in size groups up to 300-499, where a decrease from 2,029 to 764 enrollments was recorded. General science enrollment increased in all size groups above this.

Biology enrollment increased in all sizes of schools, except size group 300-499, where a decrease occurred. It is interesting to note that in the 300-499 size group the enrollment decreased in all 4 sciences (Table V). Also, all 4 sciences gained in enrollment in the 500-999 size group.

The total number of sections of the 4 main sciences offered in 1951 was: general science, 754; biology, 791; chemistry, 265; and physics, 266. In 1954 the comparable numbers were: 705 (loss of 49); 898 (gain of 107); 305 (gain of 40); and 306 (gain of 40) (Table VIII). The number of sections of general science decreased in all size groups except 10-24, 500-999, and 2,500 up. In biology, the number of sections increased or decreased only slightly in schools with enrollments of less than 200. In size group 200-299 biology sections decreased, but in all larger size groups a marked increase in biology sections was recorded. Chemistry sections remained about the same in schools with less than 100 enrollment, increased 14 sections in 100-199 size group, decreased 2 and 10 sections, respectively, in size groups 200-299 and 300-499. In the 500-999 size group, 23 more sections were offered in 1954 than in 1951. In schools with more than 25 but with less than 300 enrollment and in schools in size groups larger than 500, the number of physics sections increased.

In schools with more than 2,500 enrollment, the number of sections of the 4 main sciences increased as follows from 1951 to 1954: general science from 0 to 11, biology from 18 to 42, chemistry from 6 to 13, and physics from 3 to 13.

The number of part-time teachers increased from 752 to 877, or 17%, and the number of full-time from 177 to 219, or 23.7% from 1951 to 1954. The greatest changes in number of full-time and part-time teachers occurred in the 100-199 size group, where full-time increased from 31 to 47, or 51.6% and part-time from 58 to 161 or 178%. In the 300-499 size group full-time teachers decreased from 34 to 23 and part-time from 56 to 43. It should be noted that the enrollments and number of sections in the 4 main sciences decreased in this size group, also.

In the medium- and large-sized high schools, the average number of students taught by full-time teachers increased. But, in the smaller schools the part-time teachers taught, in general, fewer students per class than they did in 1951.

A comparison of the number of non-science courses taught by science teachers in 1951 with those of 1954 shows, in general, that no major changes have occurred (Table XXII). The number of general science, biology, chemistry, and physics teachers, who did not teach any non-science courses, increased in 1954. And the number of unidentified non-science courses taught by all science teachers in 1954 exceeded those of 1951 by a large margin. General science teachers taught fewer non-science courses in 1954 than in 1951, whereas, other science teachers taught more non-science courses in 1954. General science teachers in 1954 taught more non-science courses than did any other science teachers.

TABLE XXII. The number of non-science courses taught by general science, biology, chemistry, and physics teachers in 1951 as compared to 1954.

Science teacher	Year	None	Math	Algebra	Geometry	Industrial Arts	Woodwork, shop	Physical education	Athletics	History	Constitution	Citizenship	Music, band	Food, clothing	Library	Foreign language	Journalism, speech, English	Manual training	Driver training	Others	Total
General Science	1951	101	82	96	65	22	47	114	65	53	28	7	18	82	12	5	53	20	21	23	914
	1954	133	80	94	56	25	30	117	24	42	21	5	12	49	17	9	26	2	19	91	852
Biology	1951	117	54	68	42	14	26	103	65	58	33	10	15	72	22	8	55	9	19	20	810
	1954	147	42	57	25	21	26	123	37	49	30	8	18	56	19	8	45	4	25	103	843
Chemistry	1951	90	31	30	18	1	10	14	7	7	4	1	0	16	6	2	6	0	8	7	258
	1954	99	35	30	25	2	4	13	6	3	0	0	0	5	7	1	8	0	11	24	273
Physics	1951	78	48	52	41	7	13	23	25	17	7	3	7	6	2	1	5	3	15	7	360
	1954	92	52	73	49	10	8	24	15	8	5	1	0	5	8	2	3	1	11	28	395

Implications

The science courses of the 687 high schools studied were taught by 1,096 different teachers. Of these only 219 were full-time science teachers. The future science teacher should, it would seem, prepare himself in at least one other teaching area. The general science and biology teachers are likely to teach in any of several other major areas, as shown in Tables X and XI. However, courses in the fields of physical education, mathematics, home economics, social science, and industrial arts are most frequently taught by them. Physics and chemistry teachers (Tables XII and XIII) are less likely to teach in as wide a variety of fields as are the biology and general science teachers. Courses in fields of mathematics and physical education are most frequently taught by physics and chemistry teachers. The combination of courses most likely to be taught by science teachers has not changed materially since the Ridgway study in 1940.

It is our opinion that science teachers are unfortunate when they have to teach "physical education." Quotation marks are used because "physical education" very often really means coaching of athletics. The proper teaching of laboratory sciences is highly time consuming and so is coaching. We do not believe a "science teacher-coach combination" is conducive to good teaching in either area.

Most of the full-time science teachers in Kansas teach both biological and physical sciences. This is especially true in the smaller high schools where one science teacher often teaches general science, biology, either physics or chemistry, and probably two or more non-science courses every day. This means, if the teacher does his job properly, that he must prepare demonstration materials for general science, prepare demonstration and laboratory materials for both biology and/or physics and chemistry, and prepare a lesson for each of two or more non-science courses. The science courses, of which laboratory work is a vital part, are not taught effectively, ordinarily, under such circumstances. And, of course, the non-science courses are not taught properly either. We believe that no teacher of a science in which laboratory work is involved should have more than 4 classes per day.

Due to lack of adequate preparation of the science teachers and due to overloading of teachers of laboratory sciences, the teaching of sciences in our Kansas high schools is not satisfactory. It is our considered opinion that sciences are among the most inadequately taught subjects in our high schools.

The good science teacher should know enough about biological and physical sciences to handle the subject matter efficiently at the high school level. The National Society for the Study of Education recommended the following program for the education of high-school science

teachers: . . . "the areas of instructional techniques in which science teachers should be competent are . . .

A. For all prospective teachers of science in secondary grades:
   1. Survey of integrated course in biological science (drawing from anatomy, bacteriology, botany, ecology, entomology, health, physiology, and zoology, and possibly others, including lectures, laboratory, field work). 9 to 12 semester hours
   2. Survey or integrated course in physical science (drawing from astronomy, chemistry, geology, meteorology, and physics, and possibly others, and including lectures, laboratory, and field trips or excursions). 9 to 12 semester hours
   3. Survey or integrated coure in social science (drawing from anthropology, the development of civilization, American history with emphasis on economic, geographic, and sociological factors, and the development of political and social institutions and problems—lectures, laboratory and field work using the community as a laboratory). 9 to 12 semester hours
   4. Algebra, plane geometry, and trigonometry. 2 high-school units or 9 semester hours

B. In addition to the above, prospective teachers of general science in junior high-schools grades would take:
   1. Courses in botany, human physiology, and/or zoology. 9 to 12 semester hours
   2. Courses in chemistry and/or physics. 9 to 12 semester hours
   3. Courses in astronomy, geology, meteorology, and/or physical geography. 9 to 12 semester hours

C. Prospective teachers of science in senior high school grades would take, in addition to the survey courses 1, 2, and 3, the following:
   1. Additional work in (*a*) biological sciences (including both botany and zoology), or (*b*) chemistry or (*c*) physics to obtain a total in one area including the corresponding survey course of at least 24 semester hours.
   2. Additional work in the two areas not chosen in (1) to obtain with the other science survey an average of 18 semester hours in each or a total of 36 semester hours.

This recommendation of a minimum total of 60 semester hours in science, with 24 semester hours in one science and approximately 18 semester hours in each of two other sciences, is in close agreement with the recommendations of the Thirty-first Yearbook . . ."*

If the average high school science teacher in Kansas were as well

* The Forty-sixth Yearbook of the National Society for the Study of Education, Part I, 1947, Chapter XVI, pp. 283-284. Quoted by permission of the Society.

prepared as the National Society of the Study of Education recommended, the teaching of science in our high schools would be done much more effectively. Our requirements in Kansas are so low (p. 12 *Certificate Handbook*, March 1955) that a student might take 18 semester hours of biology and only 6 hours of physics and yet meet the minimum requirements to teach general science, biology, and physics. He could take 12 hours of biology and 6 hours each of physics and chemistry and be qualified to teach any science in any class A school. He would be "qualified," but probably unable to teach any of the courses satisfactorily. Such is the situation in the majority of our Kansas high schools.

Much concern has been expressed both by scientists and educators about the relative decrease in emphasis on the physical sciences during the last fifty years. Detailed discussion of this outside the scope of this paper, but it seems desirable to quote the following from the Forty-sixth Yearbook of the National Society for the Study of Education:

"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. The formulation of a satisfactory course in physical science, however, has been retarded by a variety of different approaches to the problem, reflecting nebulousness and confusion of ideas with respect to the nature and functions of such a course. The following considerations, therefore, are deemed to be fundamental to a satisfactory solution of the problem of providing a satisfactory course in physical science.

(*a*) The content should be planned so as to develop concepts and principles important not only in physics and chemistry but also in other branches of physical science. . . .

(*b*) Practical considerations dictate that the course should be planned for one year and not for two. . . .

(*c*) The values of a course of physical science are likely to be largely sacrificed if attempts are made to simplify it too greatly. Deeply concerned over the decreasing elections of physics and chemistry resulting from the formidable reputations of these subjects, some pioneers in the physical-science movement sought to assemble, under a variety of course and book titles designed to camouflage the nature of the course and thus to allay pupil prejudices against it, materials which would be easy enough for the ready comprehension of any of the pupils. These efforts in some cases resulted in courses that were practically on the level of effortless entertainment. They were less demanding of pupil effort and thought and, on the whole, provided a less valuable orientation in physical science than does a good course in general science intended for the junior high school.

The worth of many of these early physical-science courses was further lessened by the omission of laboratory work.

There are obviously grave difficulties in the way of organizing a course in physical science which will prove simple enough for ready comprehension by pupils of limited abilities and still retain the unique, intrinsic values attainable within this area. There seems no doubt, however, that a course of this nature can be evolved which can achieve its desired objectives through a much less technical and mathematical approach and with many more contacts with the daily lives of boys and girls than do the conventional present-day courses in physics and chemistry. If, however, physical science is to realize its full potentialities, it must be made to serve as a 'college-preparatory' and as a terminal course.

The devising of satisfactory courses in physical science is one of the greatest challenges in the field of secondary-school science. Their development is especially important for the smaller schools in which the equipping and scheduling of separate courses in physics and chemistry is often a serious problem."***

Other factors which undoubtedly help to account for the smaller enrollments in physics and chemistry in all but the large high schools are: 1. inadequate room facilities, equipment, and supplies, 2. lack of time for teachers, who are adequately prepared, to make preparation for and to teach properly 3 or 4 different laboratory sciences each day, 3. inadequate supply of teachers who are broadly enough trained in sciences so that they can teach either general science, biology, physics, or chemistry in an effective and challenging manner, and 4. a tendency for teachers of science, especially physics and chemistry teachers to discourage or frighten students away from physics and chemistry by making the courses formidably technical and discouragingly analytical.

Acceptable room facilities, equipment, and supplies could be available in the smallest high school at moderate costs, if the science teacher, the administrator, and the school board would seek advice and assistance from competent sources in planning their building and other science needs. That science facilities cost too much is more often fiction than fact.

As we mentioned earlier, the science teachers in most Kansas high schools are so over burdened with various classes that they do not have time to teach laboratory sciences as they hould be taught. The result is that many science courses include little, if any, laboratory work. A high school science course without laboratory experiences should not be called a "science" course. It seems to us that high school administrators and school boards must come to realize that a teacher of science must, by virtue of the course content and method, be allowed more time for care and preparation of equipment and supplies, and for working with students on independent projects. In many instances this would mean the addition of another teacher. However, in many other cases the science

teachers' burdens could be lessened by more careful attention to the curriculum and/or re-arranging teacher assignments.

There is a dearth of adequately prepared science teachers. Any teacher of biology should have a broad background in the other sciences if he is to do his best job of teaching biology. Of course, the converse is true, also. Any teacher of chemistry should have a broad background in biology and physics. Even the teacher of one science (biology, physics, or chemistry) in our larger high schools is better able to teach inspiringly and challengingly if he is broadly educated in the other sciences. To find such a teacher is the exception rather than the rule, unfortunately. College science teachers, who are responsible for preparing high school science teachers should work with the State Department of Public Instruction to raise the qualification standards for science teachers.

If physical science courses are developed that will encourage smaller high schools to offer them and encourage high school students to select them, the demand for high school science teachers will be greatly increased. It seems reasonable to believe that about the same number of students should be enrolled in physical science as in biological science in the high schools, instead of twice as many students in biology as in physics and chemistry combined, as shown in the present study.

About 40 years ago botany and zoology were combined into what was called general biology. With the advent of the general biology course in the high school curriculum, enrollments began to increase steadily and rapidly. Perhaps a course in physical science, as suggested in the *Forty-Sixth Yearbook of the National Society for the Study of Education*, could be developed for the 9th grade level of work. This would mean that general science would be offered in the junior high school instead of the 9th grade. This shift has already begun in Kansas. To our knowledge most of the so called "fused" physical science courses have been aimed at 11th and 12th grade levels of work. We believe that a physical science course, much like the general education course of physical science that is offered at the college level, could be developed and aimed at the 9th grade high school students. The aim and purpose of the course would be to arouse in the student a curiosity and desire to learn more about physics and chemistry when he is a 11th or 12th grader. This approach should have the advantage of leading him gradually into the more specialized physics and chemistry courses without scaring him away from these courses with an initial plunge.

In the largest Kansas high schools, where science teachers commonly teach only a single science, an advanced degree is a common requirement, either by formal action of the school system or by virtue of competition for better jobs. The prospective science teacher who has ambitions for

** Op. cit., Chapter III, pp. 45-46. Quoted by permission of the Society.

moving up to the larger schools should have enough concentation in a single science to provide a base for graduate study in that science.

Department heads and other advisors in the colleges of teacher education in Kansas, and elsewhere, should inform themselves concerning placement opportunities for science teachers, and with the working conditions of the high school science teachers so that they may help the student select courses that will fit him to select a teaching job to his best advantage. The balance between broad training in the sciences and concentration in a science is not easy to achieve. It requires the best cooperative effort of both student and teacher.

Summary

1. The High-school Principal's Organization Reports of 650 of the 650 accredited senior high schools and 37 of the 57 accredited junior high schools were examined for data concerning science teaching in Kansas high schools in 1954-1955.
2. Of the 687 schools whose reports were examined, 507 offered general science, 500 offered biology, 214 offered chemistry, and 265 offered physics .
3. The most common sciences other than general science, biology, chemistry, and physics were agriculture, physiology, physical geography, and aeronautics.
4. Of a total enrollment of about 116,000 in the high schools studied, the enrollments in the four main sciences were: general science (14,772), biology (19,250), chemistry (5,224), and physics (4,153).
5. There were 877 part-time science teachers and 219 full-time science teachers in 1954-1955.
6. The science teachers in the 687 high schools taught a total of 2,473 non-science courses. General science teachers taught 862 non-science courses, biology teachers taught 944, chemistry teachers taught 273, and physics teachers 394.
7. The median class sizes ranged from 6 to 36 in general science, from 7.5 to 31 in biology, from 3 to 28 in chemistry, and from 3 to 28 in physics.
8. The results of the present study were compared to those of our 1953 study.
9. Trends in the offering and enrollments in the secondary school sciences in Kansas were pointed out and compared to the results of other similar state and national studies.
10. Implications that were either deduced from or clearly shown by the study were listed, and opinions as to some approaches that might be made to improve secondary school science offerings in Kansas were made.

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