THE EMPORIA STATE
Research Studies

THE GRADUATE PUBLICATION OF THE KANSAS STATE TEACHERS COLLEGE, EMPORIA

Background and Academic Preparation of the Teachers of Science in the High Schools of Kansas 1955-1956

By Weldon N. Baker and Merle E. Brooks

The Emporia State Research Studies

KANSAS STATE TEACHERS COLLEGE
EMPORIA, KANSAS

Background and Academic Preparation of the Teachers of Science in the High Schools of Kansas 1955-1956

By Weldon N. Baker and Merle E. Brooks

VOLUME 6 December, 1957 NUMBER 2

THE EMPORIA STATE RESEARCH STUDIES are published in September, December, March and June of each year by the Graduate Division of the Kansas State Teachers College, Emporia, Kansas. Entered as second-class matter September 16, 1952, at the post office at Emporia, Kansas, under the act of August 24, 1912.

KANSAS STATE TEACHERS COLLEGE
EMPORIA · KANSAS

JOHN E. KING, JR.
President of the College

●

THE GRADUATE DIVISION

ORVILLE L. EATON, *Director*

EDITORIAL BOARD

This publication is a continuation of *Studies in Education* published by the Graduate Division from 1930 to 1945.

Papers published in this periodical are written by faculty members of the Kansas State Teachers College of Emporia and by either undergraduate or graduate students whose studies are conducted in residence under the supervision of a faculty member of the college.

ACKNOWLEDGMENTS

The writers wish to acknowledge the assistance of Dr. Adel Throckmorton, Dr. Floyd Herr, Dr. John E. Jacobs, and Mr. Everett Samuelson, all of the Kansas State Department of Public Instruction, and the help of Dr. Standlee Dalton of Fort Hays Kansas State College and Dr. C. R. Baird of Kansas State Teachers College of Pittsburg. Thanks are due to the following members of the Kansas State Teachers College of Emporia faculty: to Dr. John E. King, President, Dr. Don E. Davis, and Dr. Merritt Sanders for their encouragement and assistance; to Dr. John Burger and Mr. Andrew Clark, Jr. for their help with much of the detailed work; and to Dr. John Breukelman and Dr. S. Winston Cram for their cooperation in this project.

Background and Academic Preparation of the Teachers of Science in the High Schools of Kansas 1955-1956

By Weldon N. Baker and Merle E Brooks*

INTRODUCTION

If our nation is to provide the scientists that our society is demanding, then the supply of prospective scientists must be augmented at its source. The source is the secondary schools of our country. Maul (1956) states: "Slowly the realization is growing that it is in the high schools that talents are or are not identified, that native ability in certain fields is or is not nurtured, that the ambition to further study is or is not fired, and that careers in science are or are not chosen. In short, the high school (more accurately, the high school teacher) is being recognized as the key to any successful effort to increase the supply of raw material from which engineers and scientists are made."

The Forty-sixth Yearbook of the National Society for the Study of Education (1947) suggests that in any plan for the education and preparation of prospective science teachers, first consideration must be given to the kinds of positions and the responsibilities such teachers generally fill. Breukelman and Andrews (1955) made a study of the offerings and enrollment in the sciences in Kansas high schools. Their study included the subjects taught by Kansas high school science teachers, identifying trends and making comparisons with the national situation in science education.

The next consideration in formulating a plan of education for prospective teachers of science is a study of the academic preparation of the in-service teacher. It is also pertinent to know certain facts concerning the background of the in-service teacher and about his employment situation.

The purposes of this study were (1) to investigate the academic preparation of the teachers of science in Kansas; (2) to present data relevant to their background, their teaching assignment, and their teaching position; (3) to present information concerning the colleges from which they graduated.

PREVIOUS STUDIES

Comparative studies of the college preparation, teaching combinations, and salaries of Kansas high school teachers were made by Ridgway (1931), Irwin (1938), and Lockard (1946). The data for these studies

*Dr. Weldon N. Baker is Professor of Physical Science and Dr. Merle E. Brooks is Associate Professor of Biology at Kansas State Teachers College, Emporia.

were compiled from the High School Principal's Organization Reports which are on file in the office of the State Superintendent of Public Instruction, Topeka, Kansas. Transcripts of the teachers were not studied.

There are unpublished master's theses relevant to science teachers of the state, such as those of Lessig (1942) and Perry (1952).

Before World War II numerous studies were made concerning the academic preparation of the teachers of science. As early as 1907, the famous Committee of Seventeen emphasized academic preparation and professional training of science teachers. Others who investigated the preparation of science teachers were Koos and Woody (1919), Hutson (1923), Peet (1933), Noll (1939), Watkins (1939), and Burnett (1942).

Summarization of the data from the above investigations indicated that (1) a large number of science teachers were insufficiently prepared for the sciences they were teaching, especially in the small high schools; (2) the chemistry teachers were the best prepared; (3) the total training of only a few teachers fitted them to teach combinations of sciences.

Since World War II, studies have been made on the various phases of science teacher preparation in the surrounding states. Winans and Jean (1945) studied the status of junior and senior high school science teachers in the public schools of Colorado. The investigation, which was conducted by the questionnaire method, included data as to the size of the schools in which they taught, teaching combinations, majors, training, and degrees held. Winans and Jean concluded that the science teachers of the state, taken as a whole, had considerable training for their work, professionally and academically, but that in some cases, particularly in the smaller high schools, the training was decidedly inadequate. Since this study was based on 263 returns of a questionnaire sent to 449 teachers, it is possible that a preponderance of the better-trained teachers answered the questionnaire.

Anderson (1954), in a study of 803 science teachers in the secondary schools of Oklahoma, investigated the academic preparation of the science teachers, and presented data concerning their teaching assignments, their teaching positions, and their certification, along with other information of curricular nature. The data for the study were obtained from the files in the office of the State Department of Education of Oklahoma. Anderson concluded that (1) many teachers of science in the secondary schools of Oklahoma had less than the minimum college background needed and (2) new teachers of science or any teacher who plans to teach science in the smaller secondary schools of Oklahoma needs to be prepared to teach in at least four areas of science.

Wyatt (1948) surveyed the academic preparation of 683 science teachers of Missouri and compared their qualifications with the qualifica-

tions of Oklahoma, Kansas, Nebraska, Iowa, and Illinois teachers. The study indicated that the percentage of teachers failing to meet Missouri's certification requirement, 15 hours, in the sciences taught was greater in the contiguous states than in Missouri.

MATERIALS AND METHODS

This report is based on data concerning the secondary school teachers of Kansas who taught one or more science courses during the 1955-56 school year, and concerning the 650 senior high schools and the 57 junior high schools where they taught.

Data were obtained from the 1955-56 High School Principal's Organization Reports on file at the State Department of Public Instruction and from the transcripts on file in the same department. Transcripts for the teachers who graduated from Kansas State Teachers College of Emporia, Kansas State Teachers College of Pittsburg, and Fort Hays Kansas State College before 1947 were obtained by going directly to the respective registrars' offices.

The items recorded concerning the employing school of each teacher were: location and name; population of city in or near where the school was located; class of school; type of organization; enrollment; size of last graduating class.

The items recorded about each teacher were: name and population of city where teacher graduated from high school; years of experience in present position; total years of teaching experience; school from which the bachelor's degree was received; number of years since graduation; school from which the master's degree was received; number of years since receiving the master's degree; science courses taught during 1955-56; major field of interest; teaching level (junior or senior high school); age; academic preparation—credit hours in all biological and physical sciences.

A total of 1177 teachers were teaching one or more science courses in the secondary schools of Kansas. The transcripts of 1144 of these science teachers were studied, and the credit hours in each subject in the sciences recorded. The other 33 transcripts either were not on file at the Kansas State Department of Public Instruction or it was impossible to read the microfilm copy.

MAJOR FINDINGS OF THE STUDY

ENROLLMENT OF SCHOOL AND POPULATION OF CITY IN WHICH TEACHERS WERE EMPLOYED

Kansas, a farming state, has a relatively large number of small rural secondary schools. Five hundred twenty-seven teachers of science, or 46 per cent, were teaching in schools with enrollments of less than 100 students, and an additional 398, or 35 per cent, were teaching in schools with

enrollments of 100 to 499. Only 54, or 5 per cent, were teaching in schools with more than 1000 students. In fact, there were only 12 such schools in the state. The small schools were located in rural areas and small towns, with 596, or 52 per cent, of the teachers employed in towns of less than 1000 people.

CLASS OF SCHOOLS IN WHICH TEACHERS WERE EMPLOYED

The Kansas State Department of Public Instruction maintains certain policies in accrediting and classifying Kansas high schools. Classification is based upon data reported in the High School Principal's Organization Report and in most cases by personal visitation to the school. The secondary schools are classified A, B, C, or M for an indefinite period except that no minimum school (M) shall be so accredited for more than two successive years. The rating of the school is based on (1) excellence of administration, (2) effectiveness of the school program in terms of curriculum, building and equipment, library and special services, and teacher preparation, (3) evidence of good relationship between faculty, students, board of education, and community, and (4) enrollment. The minimum enrollment for a Class A school is 60 and for a Class B school 40. Of the 650 senior high schools accredited in 1955-56, 337 were able to achieve the Class A rating.

Seven hundred twenty, or 63 per cent, of the science teachers were employed in the 337 Class A Kansas secondary schools. One hundred sixty-eight teachers, or 15 per cent, were employed in the 123 Class B schools, and 197, or 17 per cent, were employed in the 170 Class C schools. Twenty Class M secondary schools employed 22 science teachers.

COLLEGES FROM WHICH TEACHERS RECEIVED BACHELOR'S DEGREES

Nine hundred nine, or 79 per cent, of the 1139 teachers for whom records were complete were graduates of Kansas colleges and universities. Of these, 565, or 49 per cent, were graduates of the five state colleges in Kansas; 292, or 25 per cent, were graduates of Kansas independent colleges; and 52, or 5 per cent, were graduates of Kansas municipal universities. The two states, other than Kansas, furnishing the most teachers were Oklahoma with 82, or 7 per cent, and Missouri with 45, or 4 per cent.

The source of teachers by type of college is given in Table I. This includes both those who graduated within the state and those who graduated outside the state. The 444 graduating from teachers colleges comprised 39 per cent of the total. In this tabulation, Fort Hays Kansas State College was considered a teachers college, since it resembles those schools at Emporia and Pittsburg more than the schools in any of the other categories. This percentage is somewhat higher than the national percentage of science teachers graduating from teachers colleges. Three hundred seventy-four, or 33 per cent, graduated from indepedent colleges; 269,

or 23 per cent, from state colleges and universities other than state teachers colleges; and 52, or 5 per cent, from municipal universities.

AGE OF TEACHERS

The teachers of science are a comparatively young group with relatively few years of experience. Almost half of them, or 49 per cent, were under 35, while only 25 per cent were above 50. As might be expected from the foregoing figures, more than half of the teachers, or 53 per cent, had less than nine years of teaching experience; almost a third, or 32 per cent, had less than five years. Moreover, these few years of teaching experience were often divided among several schools, for 707, or 61 per cent, of the teachers had less than five years of experience in their current school.

TEACHERS HOLDING THE MASTER'S DEGREE

Approximately one-third, or 365, of the 1144 science teachers had master's degrees. More than half of these degrees were obtained since 1948, and about two-thirds of them were obtained from the five state colleges of Kansas. From the standpoint of academic preparation for science teaching, it should be noted that more than half of these degrees were in education rather than in science.

TABLE I

TYPE OF COLLEGE FROM WHICH THE SCIENCE TEACHERS OBTAINED BACHELOR'S DEGREE

Type of College	Number	Per Cent
Teachers colleges	444	39
Independent colleges	374	33
State colleges and universities other than teachers colleges	269	23
Municipal universities	52	4.5
Information not available	5	0.5
Totals	1144	100

Read table thus: 444, or 39 per cent, of the graduates obtained their bachelor's degree from teachers colleges.

POPULATION OF CITY IN WHICH TEACHERS GRADUATED FROM HIGH SCHOOL

Of the 1144 science teachers on which data were compiled, 802, or 70 per cent, were graduates of Kansas high schools. More than one-fourth of these 802 teachers, 213, came from Kansas towns whose population was less than 500, as indicated in the High School Principal's Organization

Reports. However, during the 1955-56 school year, 425 science teachers were employed in towns with a population less than 500. Thus, Kansas towns in this population range produced only about one-half as many teachers as they were employing.

Three hundred forty, or 42 per cent, of the science teachers who were graduates of Kansas high schools were from cities with a population of 1000 or less, while 596, or 52 per cent, of all the science teachers were employed in towns of this size.

A similar situation existed in the large cities with a population over 50,000. Only 64 teachers were graduates of high schools in these large cities, whereas 145 science teachers were employed there.

The cities having the best record in this regard were those with a population range between 10,000 and 20,000. They produced 116 teachers, more than enough to supply the 93 they employed. No doubt one major factor in this situation is the fact that the two largest teachers colleges and a disproportionate number of the other teacher-producing colleges are located in cities of this population range.

MAJOR FIELDS OF ACADEMIC PREPARATION OF TEACHERS

Table II lists the major fields of the 1015 science teachers whose academic majors were readily ascertainable from their transcripts. The majors of 129 of the 1144 teachers were not ascertained. Those in administration were listed as such rather than by their undergraduate majors. The largest science groups were Biology, 157, General or Physical Science, 90, and Chemistry, 84. Of the non-science majors the largest group was Physical Education with 169. There were 96 Home Economics majors, 86 Mathematics majors, 51 Industrial Arts majors, and 45 Social Science majors.

Table III shows the distribution in major fields among the various age groups of science teachers. The Physical Education majors were concentrated in the three lower age groups, 20 to 35 years. This large group, whose major interest is outside the sciences, apparently tends to leave the field of science teaching, another possibility being that the teaching of science by Physical Education majors is a relatively recent development.

Table IV shows the majors of the science teachers by the colleges from which they graduated. Kansas State Teachers College of Emporia graduated more teachers, 50, who majored in science than any other individual school, most of them in Biology, Physics, and General or Physical Science. Non-state-supported schools produced almost half the Chemistry majors, 40 out of 84, and more than a third of the Biology majors, 58 out of 157.

SCIENCES TAUGHT

Table V shows the number of teachers teaching each of the listed science subjects. Individuals teaching combinations of science subjects

TABLE II

ACADEMIC MAJORS OF SCIENCE TEACHERS

Majors	Number	Per Cent
General Science	90	7.9
Biological Science		
Biology	157	13.7
Botany	7	0.6
Zoology	12	1.0
Entomology	2	0.2
Bacteriology	2	0.2
Agriculture	37	3.2
Physical Science		
Chemistry	84	7.4
Physics	26	2.3
Geology	3	0.3
Engineering	1	0.1
Other Majors		
Administration	80	7.0
Home Economics	96	8.4
Industrial Arts	51	4.5
Mathematics	86	7.5
Physical Education	169	14.7
Social Science	44	3.9
Art	1	0.1
Bible	2	0.2
Business	15	1.3
Education	19	1.7
English	13	1.1
Foreign Language	1	0.1
Health	2	0.2
Music	6	0.5
Philosophy	5	0.4
Psychology	2	0.2
Veterinary	2	0.2
Information Incomplete	129	11.3
Totals	1144	100

Read table thus: 90, or 7.9 per cent, of the 1144 Kansas high school science teachers majored in General Science.

are counted under each subject. The largest number, 539, were teaching Biology. Four hundred eighty-eight were teaching General Science, 251 were teaching Physics, 225 were teaching Chemistry, and 131 were teaching Junior High Science.

The course combinations taught by science teachers are given in Table VI. Where only one or two science courses were offered in the school, the teacher of those science subjects was assigned to teach several non-science courses. In other cases, the principal was teaching a science course. Six hundred eighty-nine teachers were teaching only one science course. This should not be interpreted to mean that there were 689 science teachers teaching science full-time; actually there were fewer than 50 full-time biology teachers, fewer than 10 full-time chemistry teachers, and even a smaller number teaching full-time in Physics. Two hundred twenty-nine taught Biology as their only science subject. A similar situation existed in General Science, where 200 were teaching General Science as their only

TABLE III

ACADEMIC MAJORS OF SCIENCE TEACHERS BY AGE

(Per cent in each age group)

Age of Teachers			20-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	Above 61
Number of Teachers	1015		105	219	193	93	66	95	91	84	69
Major	No.	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Biology	157	15.5	13.3	17.8	11.4	16.1	24.2	17.9	9.9	15.5	17.4
Science, (General, Physical, etc.)	90	8.9	10.5	8.7	6.2	7.5	6.1	10.5	11.0	10.7	11.6
Chemistry	84	8.3	1.9	6.9	9.3	6.5	7.6	10.5	12.1	14.3	7.3
Agriculture	37	3.6	1.9	0.9	4.1	2.2	1.5	6.3	4.4	6.0	10.1
Physics	26	2.6	3.8	2.3	4.7	2.2	1.5	1.1	1.1	0.0	4.4
Other Sciences (Zoology, etc.)	27	2.7	1.9	2.8	3.1	5.4	0.0	3.2	1.1	4.8	0.0
Administration	80	7.9	0.0	1.8	1.8	10.7	9.1	13.7	13.2	15.5	11.6
Physical Education	169	16.6	27.6	30.6	23.3	15.1	10.6	3.2	2.2	2.4	0.0
Home Economics	96	9.4	20.0	2.7	4.7	9.7	9.1	19.0	14.3	7.1	11.6
Mathematics	86	8.5	5.7	10.0	13.0	5.4	9.1	2.1	9.9	7.1	7.3
Industrial Arts	51	5.0	3.8	5.0	5.7	5.4	7.6	3.2	4.4	7.1	2.9
Social Science	44	4.3	5.7	2.7	3.1	4.3	6.1	4.2	7.7	3.6	1.4
Other Non-Science Majors	68	6.7	3.8	7.3	4.1	9.7	7.5	5.3	8.8	5.7	14.5

Read table thus: 157, or 15.5 per cent, of the science teachers majored in Biology. Of the 105 teachers between the age of 20-25, 13.3 per cent were Biology majors.

TABLE IV

ACADEMIC MAJOR OF SCIENCE TEACHERS BY COLLEGE FROM WHICH GRADUATED

Major	Number	Kansas State College	K.S.T.C. Emporia	K.S.T.C. Pittsburg	Ft. Hays K.S.C.	Univ. of Kans.	Other Kansas	Okla.	Mo.	Others
Science Majors										
Biology	157	7	22	21	13	14	58	8	6	8
Science (General, Physical, etc.)	90	14	13	4	5	2	28	8	6	10
Chemistry	84	9	5	7	3	4	40	2	2	12
Agriculture	37	9	3	3	8	1	2	5	5	1
Physics	26	2	10	4	2	1	4	3	0	0
Other Sciences (Zoology, etc.)	27	2	0	1	2	9	7	3	0	3
Non-Science Majors										
Administration	80	6	11	9	4	5	26	5	5	9
Physical Education	169	34	13	22	19	16	44	8	2	11
Home Economics	96	29	7	9	5	3	21	12	2	8
Mathematics	86	4	10	10	13	5	15	10	5	14
Industrial Arts	51	8	6	7	11	0	11	2	2	4
Social Science	44	5	6	2	3	0	19	5	0	4
Other Non-Science Majors	68	1	11	13	10	1	12	3	3	11
Not Known	129	16	6	7	7	11	57	8	7	13
Totals	1144	146	123	119	105	72	344	82	45	108

Read table thus: Of the 157 Biology majors, 22 received their Bachelor's degree from Kansas State Teachers College of Emporia, 21 from Kansas State Teachers College of Pittsburg, and so on.

TABLE V

NUMBER OF SCIENCE TEACHERS TEACHING EACH OF THE MAIN SCIENCE SUBJECTS

Subject	Number of Teachers
Biology	539
General Science	488
Physics	251
Chemistry	225
Junior High Science	131

Read table thus: 539 teachers were teaching Biology. Most of them were teaching other science or non-science courses also.

science subject. Eighty-three taught Physics only, and 50 taught Chemistry only. Three hundred twenty were teaching two different science courses. The most frequent combination was General Science and Biology, with 143 teachers. One hundred four teachers taught three science courses and 30 taught four courses. Further analysis of these data show that 798, or 70 per cent, of the teachers taught either Biology or General Science or both.

ACADEMIC PREPARATION OF THE TEACHERS IN THE BIOLOGICAL AND PHYSICAL SCIENCES

This portion of the study concerns the academic preparation of the in-service science teachers of Kansas. Most previous studies on the academic preparation of science teachers have been based on the number of hours of college credit in science, or in the broad fields of science, such as Biology, Chemistry, and Physics.

In the present study, the individual courses or groups of closely related courses have been recorded and tabulated. Thus, it was possible to determine the college preparation of the teachers in all of the main fields of preparation: General Biology, Botany, Chemistry, Physics, and Zoology.

It should be noted that some of the teachers may have additional preparation which does not appear in these data, that is, credit earned subsequent to the filing of the most recent transcript.

Biological Science

Table VII shows that 45 per cent of the science teachers had some credit in General Biology, and that 627, or 55 per cent, of them had no

TABLE VI

NUMBER OF SCIENCE TEACHERS TEACHING ONE OR MORE SCIENCE COURSES

Course Combinations	Number of Teachers
ONE COURSE	
Biology	229
General Science	200
Junior High Science	98
Physics	83
Chemistry	59
Physiology	11
Laboratory Science	5
Others (Zoology, etc.)	5
TOTAL	690
TWO COURSES	
General Science and Biology	143
General Science and Physics	32
Biology and Chemistry	32
Chemistry and Physics	26
General Science and Chemistry	19
Biology and Physics	17
Biology and Physiology	8
Biology and Junior High Science	7
Biology and Laboratory Science	4
Biology and Others	4
Physics and Laboratory Science	4
General Science and Laboratory Science	4
Other two course combinations	20
TOTAL	320
THREE COURSES	
General Science, Biology, and Chemistry	25
General Science, Biology, and Physics	25
Biology, Chemistry, and Physics	13
General Science, Chemistry, and Physics	11
Other three course combinations	30
TOTAL	104
FOUR COURSES	
General Science, Biology ,Chemistry, and Physics	19
Other four course combinations	11
TOTAL	30

Read table thus: 229 teachers were teaching Biology as their only science course. Most of them were teaching one or more non-science courses also.

credit in General Biology. This does not mean an entire lack of credit in the field of Biology, since many colleges do not have courses in General Biology, but enroll beginning students in General Botany or General Zoology. Relatively small numbers of teachers had college credit in Genetics, Field Biology, and Agriculture.

Table VIII shows that 479 teachers, or 42 per cent, had credit in General Botany, that 327, or 29 per cent, had Bacteriology, but that only negligible numbers had credit in any other advanced work in Botany.

Table IX indicates a similar situation in regard to Zoology, but more of the teachers had both basic and advanced work in Zoology than in Botany.

TABLE VII

NUMBER OF SCIENCE TEACHERS WITH INDICATED CREDIT HOURS IN COLLEGE BIOLOGY

Credit Hours	General Biology	Genetics	Field Courses	Other Biology	Agriculture
1	1	1	3	9	0
2	26	81	20	34	32
3	137	130	65	87	41
4	64	20	12	32	13
5	164	15	24	40	17
6	41	3	10	23	9
7	6	0	1	13	3
8	61	0	6	7	5
9	0	0	2	11	3
More than 9 hours	17	0	4	55	29
Teachers with credit	517	250	147	311	152
Per cent with credit	45	22	13	27	13

Read table thus: One science teacher had one semester hour of college credit in General Biology; a total of 517, or 45 per cent, of the science teachers had college credit in General Biology.

Physical Science

Fifty per cent of the teachers of science had college credit in Physics I, and 33 per cent had credit in Physics II (Table X). Only a few teachers had credit in advanced courses in Physics.

More teachers of science had a course in Chemistry than in any other college science. Only 29 per cent of the teachers were without credit in beginning Chemistry. Chemistry II, which in some colleges is Qualitative Analysis, had been studied by 39 per cent of the science teachers. Only 23 per cent had Organic Chemistry, and even fewer had other advanced courses in Chemistry (Table XI).

ACADEMIC PREPARATION IN TEN BASIC COURSES IN SCIENCE

Preparation in relation to subjects taught

Since there is no general agreement as to the academic preparation and subject-matter competence of the science teacher, the authors have arbitrarily chosen what they considered to be ten basic science courses that are essential for the effective teaching of high school science.

Table XII shows the "basic ten" and gives the number and per cent of the teachers with credit in the respective subjects. With the exception of Field Biology and Modern Physics, these ten are the courses most fre-

TABLE VIII

NUMBER OF SCIENCE TEACHERS WITH INDICATED CREDIT HOURS IN COLLEGE BOTANY

Credit Hours	General Botany	Microbiology or Bacteriology	Plant Anatomy	Plant Morphology	Plant Physiology
1	1	0	0	0	1
2	22	12	1	0	4
3	86	133	11	10	10
4	68	33	4	6	3
5	194	131	5	5	6
6	63	8	0	2	1
7	6	2	0	0	0
8	16	1	1	1	1
9	2	3	0	1	0
More than 9 hours	21	4	0	0	0
Teachers with credit	479	327	22	25	26
Per cent with credit	42	29	2	2	2

Read table thus: One science teacher had one semester hour college credit in General Botany; 479, or 42 per cent, of the science teachers had college credit in General Botany.

quently taken by the in-service teachers of Kansas, in the preparation for science teaching. Qualitative Analysis was combined with Chemistry II since in many schools Qualitative Analysis follows Chemistry I.

The college courses taken most frequently by the group as a whole were Chemistry I (71 per cent), Zoology (55 per cent), Physics (51 per cent), and Chemistry II (50 per cent). The general science teachers and the junior high science teachers had essentially the same preparation as the entire group.

In the "basic ten" courses, the chemistry teachers had the most credit. Ninety-six per cent had Chemistry I, 80 per cent Chemistry II, and 56 per cent Organic Chemistry. Seventy-one per cent had Physics I, 55 per cent Physics II, and 53 per cent Zoology.

The physics teachers showed about the same preparation in both first-year physics and first-year chemistry: eighty-four per cent had Physics I and 66 per cent Physics II; 83 per cent had Chemistry I and 66 per cent Chemistry II. The physics teachers' preparation in the biological sciences was below the average of the whole group.

Of the biology teachers, 66 per cent had credit in Zoology, 58 per cent in Botany, and 47 per cent in General Biology. In some colleges "General Biology" is actually a course in Zoology and Botany. This made it

TABLE IX

NUMBER OF SCIENCE TEACHERS WITH INDICATED CREDIT HOURS IN COLLEGE ZOOLOGY

Credit Hours	General Zoology	Comp. Anat.	Human & Gen. Phys.	Embryology	Ento-mology
1	1	0	0	0	0
2	22	5	32	4	7
3	88	28	181	25	36
4	75	30	85	40	8
5	306	118	139	42	14
6	23	7	17	1	1
7	8	2	11	0	2
8	30	1	20	0	1
9	4	0	24	0	1
More than 9 hours	26	3	9	0	1
Teachers with credit	583	194	518	112	71
Per cent with credit	51	17	45	10	6

Read table thus: One science teacher had one semester hour of college credit in General Zoology; 583, or 51 per cent, of the science teachers had college credit in General Zoology.

difficult to determine whether or not a given individual had actually taken Zoology and Botany. Table XIII lists the teachers who had no college credit in any of these three courses: General Biology, Botany, and Zoology. Forty-one, or 7.6 per cent, of the biology teachers and eighty-six, or 17.7 per cent, of the general science teachers did not have any college credit in General Biology, Botany, and Zoology.

Preparation in relation to age

The academic preparation in the ten basic science courses analyzed in relation to age of teacher is given in Table XIV. The teachers between the ages of 46 and 50 years of age had the highest percentage of "basic" courses, rating high in Botany, Zoology, Chemistry I, Chemistry II, and Organic Chemistry. However, the teachers between 51 and 55 years of age had the highest percentage of courses in Physics I and Physics II. The percentage of teachers with credit in Physics and Chemistry was less among the younger teachers than among the older teachers. This might be expected, since Table XIII on academic majors shows that there were a higher percentage of non-science majors among the younger teachers than among the older ones. The high percentage of credit in General Biology among the younger teachers is no doubt due to the fact that General Biology is a relatively recent addition to the science curriculum of the colleges.

TABLE X

NUMBER OF SCIENCE TEACHERS WITH INDICATED CREDIT HOURS IN COLLEGE PHYSICS

Credit Hours	Physics I	Physics II	Electricity	Heat	Modern Physics	Radio	Light	Other Courses
1	0	0	0	0	1	0	0	5
2	7	1	7	8	10	29	3	30
3	65	40	19	11	30	18	8	65
4	175	120	12	6	2	3	10	23
5	304	205	11	6	2	7	12	28
6	13	4	5	1	2	2	1	8
7	1	1	0	2	1	0	0	8
8	4	1	2	0	0	1	0	4
9	0	0	0	0	0	0	0	3
More than 9 hours	1	0	1	0	0	1	0	12
Teachers with credit	570	372	57	34	48	61	34	186
Per cent with credit	50	33	5	3	4	5	3	16

Read table thus: Seven science teachers had two semester hours college credit in Physics I; 570 science teachers, or 50 per cent, had college credit in Physics I.

TABLE XI

NUMBER OF SCIENCE TEACHERS WITH INDICATED CREDIT HOURS IN COLLEGE CHEMISTRY

Credit Hours	Chem. I	Chem. II	Org. Chem.	Qual. Anal.	Quant. Anal.	Bio. Chem.	Phys. Chem.	Other Courses
1	0	0	0	1	0	0	0	3
2	5	5	0	6	5	5	0	12
3	32	57	37	39	33	9	6	10
4	214	152	31	36	19	2	10	11
5	533	225	161	128	67	10	15	13
6	16	7	11	4	7	2	2	7
7	1	0	4	0	4	0	0	0
8	7	2	21	3	13	0	5	4
9	0	0	6	3	3	1	1	0
More than 9 hours	3	0	35	1	7	2	3	12
Teachers with credit	811	448	306	221	158	31	42	72
Per cent with credit	71	39	27	19	14	3	4	6

Read table thus: 5 teachers had two semester hours college credit in Chemistry II; 811 teachers, or 71 per cent, had college credit in Chemistry I.

TABLE XII

SCIENCE TEACHERS, GROUPED BY SUBJECT TAUGHT, HAVING COLLEGE CREDIT IN TEN BASIC COLLEGE SCIENCE COURSES

	All Science Teachers		General Science Teachers		Biology Teachers		Chemistry Teachers		Physics Teachers		Junior High Science Teachers	
Number of Teachers	1144		488		539		225		251		131	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
General Biology	486	43	215	44	254	47	83	37	101	40	50	40
Botany	533	47	225	46	310	58	100	45	91	36	68	52
Zoology	627	55	263	54	358	66	120	53	116	46	80	61
Field Biology	123	11	49	10	72	13	27	12	28	11	17	13
Chemistry I	810	71	336	69	368	68	215	96	208	83	87	67
Chemistry II	571	50	224	46	249	46	179	80	166	66	65	50
Organic Chemistry	302	27	123	25	147	27	125	56	81	32	29	22
Physics I	579	51	227	47	240	58	159	71	210	84	57	44
Physics II	395	35	154	32	159	30	123	55	166	66	32	24
Modern Physics	46	4	16	3	16	3	15	7	24	10	3	2

Read table thus: There are 488 General Science teachers, of these 215, or 44 per cent, had credit in General Biology.

TABLE XIII

SCIENCE TEACHERS WHO HAD NO COLLEGE CREDIT IN GENERAL BIOLOGY, BOTANY, AND ZOOLOGY

Science Teachers	Number	Number Without Credit	Per Cent Without Credit
All Science Teachers	1144	188	16.4
Biology Teachers	539	41	7.6
General Science Teachers	488	86	17.7
Junior High Science Teachers	131	18	13.7

Read table thus: Of the 1144 science teachers, 188, or 16.4 per cent, had no credit in General Biology, Botany, and Zoology.

Preparation in relation to class of school in which teaching

The classification of Kansas high schools into Classes A, B, C, and M is determined in part by the academic preparation of the teachers. Table XV shows that the science teachers in the Class A schools had credit in slightly more science courses than those in the other three classes. This is to be expected since the requirements are higher for teachers in Class A schools. There were no appreciable differences among the Class B, C, and M schools in the preparation of their science teachers. The preparation of teachers in Class B, C, and M schools was somewhat lower in the physical sciences than that of the teachers in Class A schools.

ACADEMIC PREPARATION BY COLLEGES OR UNIVERSITIES FROM WHICH GRADUATED

The science course preparation of the science teachers who were graduates of the different colleges is given in Tables XVI to XXII. Because of the number of courses involved, these data are difficult to analyze. Of the 146 science teachers who were graduates of Kansas State College (Table XVI), a relatively higher percentage, as compared with the entire group of science teachers, had credit in the beginning college courses, such as Botany, Zoology, Chemistry I and II, Organic Chemistry, and Physics I and II. On the other hand, these teachers had taken relatively fewer advanced courses than the average for the entire group.

The 123 teachers who were graduates of Kansas State Teachers College of Emporia (Table XVII) had credit in a relatively higher percentage of advanced courses. This agrees with the data of Table IV on academic majors, which shows that Kansas State Teachers College of Emporia had produced the largest number of science teachers who had academic majors in one of the science fields.

TABLE XIV

SCIENCE TEACHERS, BY AGE GROUPS, HAVING CREDIT IN TEN BASIC COLLEGE SCIENCE COURSES

Age of Teachers	20-25		26-30		31-35		36-40		41-45		46-50		51-55		56-60		Above 61	
Number of Teachers	112		241		207		97		77		112		111		100		79	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
General Biology	63	56	131	54	97	47	42	43	21	27	30	27	42	38	37	37	17	22
Botany	50	45	113	47	84	41	52	53	35	46	67	60	51	46	45	45	31	39
Zoology	64	57	137	57	115	56	59	61	46	60	67	60	55	50	46	46	33	42
Field Biology	5	4	25	10	15	7	17	18	12	16	15	13	9	8	13	13	12	15
Chemistry I	74	66	144	60	147	71	74	76	56	72	92	82	83	75	79	79	55	70
Chemistry II	40	36	105	44	101	49	52	54	40	52	74	66	65	59	56	56	34	43
Organic Chemistry	29	26	57	24	61	30	26	27	22	29	33	30	32	29	21	21	19	24
Physics I	38	34	120	50	110	53	48	50	40	52	62	55	68	61	50	50	37	47
Physics II	25	22	86	36	79	38	30	31	27	35	41	37	49	44	31	31	22	38
Modern Physics	5	4	10	4	13	6	4	4	5	7	4	4	1	1	2	2	2	3

Read table thus: Of the 112 teachers of age 20 to 25, 63, or 56 per cent, had college credit in General Biology.

TABLE XV

SCIENCE TEACHERS, GROUPED BY CLASS OF SCHOOL IN WHICH EMPLOYED, HAVING COLLEGE CREDIT IN TEN BASIC COLLEGE SCIENCE COURSES

Class of School	A		B		C		M		B, C & M Combined	
Number of Teachers	720		168		197		22		387	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
General Biology	307	43	77	46	82	42	9	41	168	44
Botany	338	47	74	44	86	44	12	55	172	45
Zoology	401	56	87	52	101	51	10	46	198	51
Field Biology	91	13	11	7	14	7	1	5	26	7
Chemistry I	533	74	106	63	122	62	17	77	245	63
Chemistry II	400	56	63	38	72	37	10	46	145	38
Organic Chemistry	222	31	34	20	31	16	5	23	70	18
Physics I	402	56	76	45	73	37	8	36	157	40
Physics II	292	41	43	26	44	22	5	23	92	24
Modern Physics	36	5	4	3	4	2	0	0	8	2

Read table thus: Of the 720 teachers in Class A schools, 307, or 43 per cent, had college credit in General Biology.

TABLE XVI

CREDIT HOURS IN THE SCIENCE COURSES OF THE 146 GRADUATES OF KANSAS STATE COLLEGE WHO WERE TEACHING SCIENCE IN KANSAS

Number of Credit Hours	1	2	3	4	5	6	More Than 6 Hours	No Credit Number	No Credit Per Cent
General Biology	0	2	6	5	3	0	11	119	81.6
Botany	0	0	17	1	18	29	1	80	54.8
Zoology	0	1	1	2	91	5	4	42	28.8
Microbiology or Bacteriology	0	2	37	5	11	1	0	90	61.7
Genetics	0	1	9	0	4	0	0	132	90.5
Comp. Anatomy	0	0	1	1	15	0	0	129	88.4
Physiology	0	2	12	25	8	1	22	76	52.0
Embryology	0	2	5	6	2	0	0	131	89.8
Field Courses (Field Biology, Ecology)	0	0	5	0	2	0	0	139	95.3
Other Biology Courses	0	1	4	2	4	3	3	129	88.4
Chemistry I	0	0	2	20	91	1	2	30	20.5
Chemistry II	0	0	7	17	57	2	0	63	43.1
Organic Chemistry	0	0	8	5	30	0	5	98	67.2
Qual. Anal.	0	0	3	3	6	0	0	134	91.9
Quant. Anal.	0	2	3	1	2	1	3	134	91.9
Biochemistry	0	0	0	0	2	0	0	144	98.7
Physical Chemistry	0	0	1	0	1	0	4	140	96.0
Advanced Chemistry	1	0	0	0	1	1	2	141	96.7
General Physics I	0	0	7	50	21	3	1	64	43.8
General Physics II	0	0	3	35	15	1	0	92	63.1
Electricity	0	1	1	0	1	0	0	143	97.1
Heat	0	0	0	0	1	0	0	145	99.4
Modern Physics	0	2	0	0	0	0	0	144	98.7
Radio	0	2	0	0	0	0	0	144	98.7
Light	0	0	0	3	0	0	0	143	97.1
General Physics or Physical Science	1	0	9	12	1	0	16	107	73.4
Other Advanced Physics	0	2	10	1	0	2	2	129	88.4
Entomology	0	1	7	0	0	0	1	137	93.9
Agriculture	0	2	8	2	3	0	6	125	85.7

Read table thus: 3 teachers had five hours credit in General Biology; 119 teachers, or 81.6 per cent, had no credit in General Biology.

TABLE XVII

CREDIT HOURS IN THE SCIENCE COURSES OF THE 123 GRADUATES OF KANSAS STATE TEACHERS COLLEGE OF EMPORIA WHO WERE TEACHING SCIENCE IN KANSAS

Number of Credit Hours	1	2	3	4	5	6	More Than 6 Hours	No Credit Number	No Credit Per Cent
General Biology	0	6	39	4	9	3	3	59	48.0
Botany	0	8	20	3	17	5	2	68	55.3
Zoology	1	3	21	5	17	0	4	72	58.5
Microbiology or Bacteriology	0	1	24	3	13	0	0	82	66.6
Genetics	0	2	19	0	0	0	0	102	83.0
Comp. Anatomy	0	2	5	1	12	2	0	101	82.8
Physiology	0	7	15	2	24	0	1	74	60.1
Embryology	0	0	1	0	8	0	0	114	92.7
Field Courses (Field Biology, Ecology)	0	11	11	2	6	0	0	93	75.6
Other Biology	2	9	6	8	6	3	13	76	61.8
Chemistry I	0	0	2	9	71	1	0	40	32.5
Chemistry II	0	0	13	5	28	0	0	77	62.6
Organic Chemistry	0	0	4	1	25	1	0	90	73.1
Qual. Anal.	0	1	8	2	12	1	0	99	80.5
Quant. Anal.	0	1	0	4	3	0	1	114	92.7
Biochemistry	0	3	0	0	0	1	0	119	96.8
Physical Chemistry	0	0	0	0	2	0	0	121	98.4
Advanced Chemistry	0	3	0	1	0	0	1	118	96.0
General Physics I	0	0	5	5	50	1	0	62	50.4
General Physics II	0	0	5	2	37	0	1	78	63.4
Electricity	0	0	1	4	1	0	0	117	95.2
Heat	0	6	0	0	2	1	2	112	91.1
Modern Physics	0	0	8	0	0	0	0	115	93.5
Radio	0	17	4	0	1	0	0	101	82.1
Light	0	1	0	1	4	0	0	117	95.1
General Physics or Physical Science	0	6	19	0	12	1	4	81	65.8
Other Advanced Physics	0	5	10	2	5	0	5	96	78.0
Entomology	0	0	5	1	0	0	0	117	95.1
Agriculture	0	7	5	3	3	3	10	92	74.8

Read table thus: 39 teachers had three hours credit in General Biology; 59 teachers, or 48 per cent, had no credit in General Biology.

TABLE XVIII

CREDIT HOURS IN THE SCIENCE COURSES OF THE 119 GRADUATES OF KANSAS STATE TEACHERS COLLEGE OF PITTSBURG WHO WERE TEACHING SCIENCE IN KANSAS

Number of Credit Hours	1	2	3	4	5	6	More Than 6 Hours	No Credit	
								Number	Per Cent
General Biology	0	3	11	5	26	2	6	66	55.4
Botany	0	4	3	5	28	2	1	78	65.5
Zoology	0	5	4	1	29	1	2	77	64.7
Microbiology or Bacteriology	0	0	4	6	39	0	0	70	58.8
Genetics	0	32	10	9	1	0	0	67	56.2
Comp. Anatomy	0	0	1	0	3	1	1	113	95.0
Physiology	0	3	20	17	23	2	9	45	37.8
Embryology	0	0	4	0	5	0	0	110	92.5
Field Courses (Field Biology, Ecology)	0	2	8	1	2	2	1	103	86.6
Other Biology	2	4	13	3	3	2	12	80	67.2
Chemistry I	0	1	1	12	64	0	0	41	34.4
Chemistry II	0	0	2	6	6	0	0	105	88.2
Organic Chemistry	0	0	3	1	23	0	2	90	75.6
Qual. Anal.	0	0	5	3	33	0	1	77	64.7
Quant. Anal.	0	0	1	1	19	0	1	97	81.5
Biochemistry	0	0	1	0	0	0	0	118	99.2
Physical Chemistry	0	0	0	1	3	0	0	115	96.6
Advanced Chemistry	1	1	1	0	4	0	0	112	94.2
General Physics I	0	1	4	11	37	0	0	66	55.4
General Physics II	0	0	3	6	22	0	0	88	73.9
Electricity	0	1	5	0	6	0	1	106	89.1
Heat	0	1	2	0	0	0	0	116	97.5
Modern Physics	0	0	8	0	0	0	0	111	93.3
Radio	0	3	1	0	0	0	1	114	95.8
Light	0	1	1	0	0	0	0	117	98.4
General Physics or Physical Science	0	8	2	0	8	1	2	98	82.3
Other Advanced Physics	0	4	5	1	3	2	3	101	84.9
Entomology	0	4	1	1	1	0	0	112	94.2
Agriculture	0	0	8	0	3	1	3	104	87.4

Read table thus: 26 teachers had five hours credit in General Biology; 66, or 55.4 per cent, had no credit in General Biology.

TABLE XIX

CREDIT HOURS IN THE SCIENCE COURSES OF THE 105 GRADUATES OF FORT HAYS KANSAS STATE COLLEGE WHO WERE TEACHING SCIENCE IN KANSAS

Number of Credit Hours	1	2	3	4	5	6	More Than 6 Hours	No Credit Number	No Credit Per Cent
General Biology	1	3	5	3	51	0	9	33	31.4
Botany	0	4	3	3	24	1	10	60	57.1
Zoology	0	6	6	6	32	1	8	46	43.8
Microbiology or Bacteriology	0	0	0	0	18	0	0	87	82.7
Genetics	0	1	13	1	0	0	0	90	85.6
Comp. Anatomy	0	1	2	0	12	0	1	89	84.7
Physiology	0	2	6	0	13	0	2	82	78.0
Embryology	0	0	0	0	2	0	0	103	98.1
Field Courses (Field Biology, Ecology)	0	0	8	0	8	4	6	79	75.1
Other Biology Courses	0	1	14	0	6	2	8	74	70.5
Chemistry I	0	0	0	13	54	0	0	38	36.2
Chemistry II	0	0	0	5	20	0	0	80	76.1
Organic Chemistry	0	0	0	1	18	0	0	86	81.8
Qual. Anal.	0	0	0	0	11	0	0	94	89.5
Quant. Anal.	0	0	0	0	5	0	0	100	95.2
Biochemistry	0	0	1	0	0	0	0	104	99.0
Physical Chemistry	0	0	0	0	0	0	0	105	100.0
Advanced Chemistry	0	0	1	0	2	0	2	100	95.2
General Physics I	0	2	1	9	31	0	0	62	59.0
General Physics II	0	0	1	5	19	0	0	80	76.1
Electricity	0	1	1	1	0	1	0	101	96.2
Heat	0	0	1	0	2	0	0	102	97.2
Modern Physics	0	0	2	0	0	0	0	103	98.1
Radio	0	1	4	0	3	0	0	97	92.3
Light	0	0	1	0	3	0	0	101	96.2
General Physics or Physical Science	0	0	1	1	24	0	1	78	74.2
Other Advanced Physics	0	1	1	1	6	0	3	93	88.5
Entomology	0	1	2	0	2	0	0	100	95.2
Agriculture	0	3	3	4	4	1	12	78	74.2

Read table thus: 51 teachers had five hours credit in General Biology; 33, or 31.4 per cent, had no credit in General Biology.

TABLE XX

CREDIT HOURS IN THE SCIENCE COURSES OF THE 72 GRADUATES OF KANSAS UNIVERSITY WHO WERE TEACHING SCIENCE IN KANSAS

Number of Credit Hours	1	2	3	4	5	6	More Than 6 Hours	No Credit Number	No Credit Per Cent
General Biology	0	2	18	0	9	3	1	39	54.2
Botany	0	3	6	1	18	1	2	41	57.0
Zoology	0	0	10	1	26	0	2	33	45.8
Microbiology or Bacteriology	0	0	5	0	7	1	1	58	80.6
Genetics	0	5	4	0	2	0	0	61	84.8
Comp. Anatomy	0	0	0	2	26	0	0	44	61.1
Physiology	0	1	15	4	12	0	6	34	47.2
Embryology	0	0	1	0	10	0	0	61	84.8
Field Courses (Field Biology, Ecology)	1	2	8	1	2	0	2	56	77.8
Other Biology Courses	0	3	7	1	1	1	14	45	62.5
Chemistry I	0	0	0	4	41	1	0	26	36.1
Chemistry II	0	0	2	1	15	0	0	54	75.0
Organic Chemistry	0	0	2	0	12	0	3	55	76.4
Qual. Anal.	0	0	6	1	17	0	0	54	75.0
Quant. Anal.	0	1	5	0	4	0	1	61	84.7
Biochemistry	0	0	0	0	0	0	2	70	97.2
Physical Chemistry	0	0	1	1	1	0	0	69	95.9
Advanced Chemistry	0	1	1	0	0	0	0	70	97.2
General Physics I	0	0	4	7	19	0	2	40	55.6
General Physics II	0	0	2	3	16	0	0	51	70.9
Electricity	0	1	0	0	0	2	0	69	95.9
Heat	0	0	0	0	0	0	0	72	100.0
Modern Physics	0	0	2	0	1	0	0	69	95.9
Radio	0	0	0	1	0	0	0	71	98.6
Light	0	0	1	0	1	0	0	70	97.2
General Physics or Physical Science	0	2	2	1	6	0	1	60	83.3
Other Advanced Physics	0	2	4	0	4	0	4	58	80.5
Entomology	0	0	1	1	7	0	3	60	83.3
Other Agriculture	0	2	1	0	0	1	0	68	94.5

Read table thus: 9 teachers had five hours credit in General Biology; 39 teachers, or 54.2 per cent, had no credit in General Biology.

TABLE XXI

CREDIT HOURS IN THE SCIENCE COURSES OF THE 20 GRADUATES OF WASHBURN UNIVERSITY WHO WERE TEACHING SCIENCE IN KANSAS

Number of Credit Hours	1	2	3	4	5	6	More Than 6 Hours	No Credit Number	No Credit Per Cent
General Biology	0	0	6	0	5	0	0	9	45.0
Botany	0	0	1	0	0	0	2	17	85.
Zoology	0	0	7	0	2	0	1	10	50.
Microbiology or Bacteriology	0	0	1	0	2	0	0	17	85.
Genetics	0	1	2	0	0	0	0	17	85.
Comp. Anatomy	0	0	0	0	3	0	0	17	85.
Physiology	0	1	3	1	5	2	1	7	35.
Embryology	0	0	0	0	1	0	0	19	95.
Field Courses (Field Biology, Ecology)	0	0	4	0	0	0	0	16	80.
Other Biology Courses	0	0	2	1	1	0	2	14	70.
Chemistry I	0	0	0	1	5	0	0	14	70.
Chemistry II	0	0	0	0	2	0	0	18	90.
Organic Chemistry	0	0	1	0	2	0	0	17	85.
Qual. Anal.	1	0	0	0	1	0	0	18	90.
Quant. Anal.	0	0	0	1	1	0	0	18	90.
Biochemistry	0	0	0	0	0	0	0	20	100.
Physical Chemistry	0	0	0	0	0	0	0	20	100.
Advanced Chemistry	0	0	0	0	0	0	0	20	100.
General Physics I	0	0	3	1	5	0	0	11	55.
General Physics II	0	0	1	1	3	0	0	15	75.
Electricity	0	0	0	0	0	0	0	20	100.
Heat	0	0	0	0	0	0	0	20	100.
Modern Physics	0	0	0	0	0	0	0	20	100.
Radio	0	0	0	0	0	0	0	20	100.
Light	0	0	0	0	0	0	0	20	100.
General Physics or Physical Science	0	0	1	1	0	1	1	16	80.
Other Advanced Physics	0	1	2	0	1	0	0	16	80.
Entomology	0	0	0	0	1	0	0	19	95.
Agriculture	0	0	1	0	0	0	0	19	95.

Read table thus: 5 teachers had five hours credit in General Biology: 9 teachers, or 45 per cent, had no credit in General Biology.

TABLE XXII

CREDIT HOURS IN THE SCIENCE COURSES OF THE 32 GRADUATES OF WICHITA UNIVERSITY WHO WERE TEACHING SCIENCE IN KANSAS

Number of Credit Hours	1	2	3	4	5	6	More Than 6 Hours	No Credit Number	No Credit Per Cent
General Biology	0	0	3	0	5	0	1	23	71.9
Botany	0	0	0	1	13	0	3	15	46.8
Zoology	0	1	2	2	11	1	0	15	46.8
Microbiology or Bacteriology	0	9	1	0	9	0	1	21	65.6
Genetics	0	9	1	0	0	0	0	22	68.6
Comp. Anatomy	0	0	0	0	5	0	0	27	84.4
Physiology	0	0	8	3	5	0	1	15	46.8
Embryology	0	0	1	0	2	0	0	29	90.6
Field Courses (Field Biology, Ecology)	0	1	3	0	1	0	0	27	84.4
Other Biology Courses	0	3	1	1	2	1	6	18	56.2
Chemistry I	0	0	0	6	13	0	0	13	40.6
Chemistry II	0	0	0	5	5	0	0	22	68.6
Organic Chemistry	0	0	1	0	3	0	0	28	87.5
Qual. Anal.	0	1	0	0	5	1	0	25	78.0
Quant. Anal.	0	0	0	0	3	0	1	28	87.5
Biochemistry	0	0	0	0	0	0	0	32	100.0
Physical Chemistry	0	0	0	0	0	0	0	32	100.0
Advanced Chemistry	0	0	0	0	0	0	1	31	96.9
General Physics I	0	2	0	2	8	0	0	20	62.5
General Physics II	0	0	0	2	6	0	0	24	75.0
Electricity	0	0	0	0	0	0	0	32	100.0
Heat	0	0	0	0	0	0	0	32	100.0
Modern Physics	0	0	0	0	0	0	0	32	100.0
Radio	0	0	0	0	0	0	0	32	100.0
Light	0	0	0	0	0	0	0	32	100.0
General Physics or Physical Science	0	2	1	0	3	0	1	25	78.1
Other Advanced Physics	0	0	0	0	1	0	1	30	93.8
Entomology	0	0	1	0	0	0	0	31	96.9
Agriculture	0	0	1	0	1	0	0	30	93.8

Read table thus: 5 teachers had five hours credit in General Biology; 181 teachers, or 52.6 per cent, had no credit in General Biology.

The 296 teachers who were graduates of the other three state schools (Tables XVIII, XIX, and XX) had credit in somewhat fewer science courses than those from Kansas State College and Kansas State Teachers College of Emporia.

The 52 graduates of the two municipal universities (Tables XXI and XXII) had credit in relatively fewer courses in science, particularly in the physical sciences.

DISCUSSION

The primary objective of the present study was to obtain information concerning the academic preparation of the teachers of science in Kansas. These data show that many teachers did not have courses in one or more of the sciences. This is evident when 55 per cent of the teachers did not have a course in General Biology, 49 per cent did not have a course in General Zoology, 58 per cent did not have a course in Botany, 50 per cent did not have a course in Physics I, and 29 per cent did not have a course in beginning Chemistry. Because of the interrelationship of the sciences, it is considered desirable in the understanding of any science to have basic knowledge of the other sciences. This would imply that the science teacher should have broad training in the sciences as well as sufficient specialization to teach one or more sciences, such as Biology, Physics, or Chemistry.

A report by the Co-operative Committee on Science Teaching (1946) recommends that approximately one-half of the work for the baccalaureate degree for the science teacher be in the sciences. This report agrees with the recommendation of the National Society for the Study of Education (1946) which suggests the following program for training teachers:

A. For all prospective teachers of science in secondary grades:
   1. Survey or 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 course 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 school 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.

If the above recommended program comprising a minimum of 60 semester hours in science, with 24 semester hours in one science and approximately 18 semester hours in each of the other sciences, were adopted, the assumption might follow that teaching of science in the high schools should be more effective.

In a recommendation made by the Southeastern Conference on Biology Teaching of the National Association of Biology Teachers (1955), it was agreed that a balanced program for the biology teacher to be completed in four years would leave much to be desired. However, the Conference took a realistic view of the high school teaching situation as it exists now and recommended as minimum requirements the following program for the prospective high school teacher:

a. A college major (i. e., a minimum of 24 semester hours) in the biological sciences, to include one year of general biology, or equivalent courses in general botany and general zoology (incorporating the subject matter areas of morphology, taxonomy, physiology and health, ecology and conservation, heredity and development, evolution and paleontology), with at least one-third of the total content devoted to plant science. Course work beyond the first year should include field studies.

b. One year of chemistry, with laboratory work. It was recommended that this work include organic chemistry as it applies to living things.

c. One year of physics, with laboratory work.

d. One half-year of earth science.

e. One year of mathematics.

f. Education courses to meet state certification requirements, with a course in methods of teaching high school biology strongly recommended. Professional education courses should include experiences in the following areas:

(1) The nature of the learning process.

(2) Human growth and development.

(3) Professional laboratory experiences.

(4) Internship.

(5) Group dynamics.

(6) The secondary school program (the role of the school in society, curriculum, history and philosophy of education, and the like).

(7) Testing and evaluation.

g. Appropriate general education courses (humanities, social sciences, and communication skills) required of other high school teachers.

It should be noted that the above recommendations point to the need of a well-rounded academic program in the training of science teachers. It is especially desirable that the general science teacher be adequately prepared in all of the science areas. While it was apparent from this study that a large number of non-science majors were teaching General Science, it seems highly improbable that these teachers who had only a minor in science could be well prepared in all the areas. The above-mentioned report of the Co-operative Committee on Science Teaching (1946) further recommends that certification to teach General Science be limited to those having college courses in all the subjects concerned in General Science—Botany, Zoology, Physics, and Chemistry.

The authors feel that it would be a waste of time to point a finger of blame for the less-than-ideal situation in regard to the preparation of science teachers in Kansas. It is rather their purpose to call attention to methods of attack on the problem which would seem to show most chance of success.

A division of the problem into two general areas of attack naturally presents itself: the continued improvement in the academic background of the in-service science teacher, and the improvement in preparation of the science teacher-in-training.

It has been the authors' privilege, since the inception of this study, to have participated in the program of one of the National Science Foundation Summer Institutes for Teachers of High School Science. The success of the Institute program, and the flood of applications which were received for the limited number of appointments available indicated both the interest of the in-service teacher in improving his professional preparation, and a clue to one of the principal deterrents that may stand in his way, namely, his financial status. It is suggested that a school board could make few investments better calculated to improve the quality of instruction in a school than by offering a "fringe benefit" summer fellowship to a promising science teacher who stands in need of further training.

The problem of a program of studies for the teacher-in-training is of a two-fold nature. The first and most easily solved aspect of the problem concerns the student who prepares for a career in science or science teaching as a matter of choice. The second and more difficult is the problem of the non-science major who finds himself confronted with the necessity of teaching a science course in addition to courses in his major field. Since there is apparently no lack of offerings in science among the teacher-preparing institutions in Kansas, the solution of both aspects of the problem would seem to lie in better advisement from the high school level on through the junior college and senior college levels.

Advisement for the prospective scientist or science teacher must of necessity begin at the high school level, since the logical sequence of courses in science on the college level depends on the previous preparation of the student in algebra and geometry in his high school training. It is important that the future scientist in the high school should be aware of the necessity of training in mathematics.

Advisors in the teacher preparing institutions should be well-informed concerning teaching opportunities, both for the science major who will probably teach only science, and the non-science major who may make science a part of his teaching combination; the type of preparation necessary for each should be thoroughly familiar not only to advisors in the science departments, but also to the other major advisors. Logical sequence in courses should receive the necessary attention, especially in the junior colleges, whose transfer students should have basic training in botany, zoology, chemistry, and physics in order to be able to devote their junior and senior years to the necessary theory and practice teaching courses, along with advanced study in their major field.

Above all, the prospective teacher should be encouraged to feel that certification requirements in no way represent the limit of his responsibility to prepare himself adequately for one of the most exciting and rewarding careers open to the service-minded individual.

NEEDED RESEARCH IN SCIENCE EDUCATION IN KANSAS

Topics which showed promise of providing additional information needed to better understand teachers of science and their problems were suggested by the findings of the present study. It would be significant to know at what age the individual became interested in science, and what the experiences were that influenced him in his choice of science teaching. What is the relative importance of the grade school teacher, the high school teacher, and the parents so far as their influence on career choice is concerned?

What is the correlation between academic preparation and the quality of teaching? A long-range program might be set up and carried to completion on the accomplishments of pupils who studied under a science teacher with a bare minimum of preparation to teach science as compared to students with equal measurable ability who studied under a well-prepared science teacher.

Research is needed in the type and amount of equipment that is necessary to teach science effectively. Especially in the smaller schools, it seems probable from a study of individual teacher records that equipment available determined course offerings rather than teacher preparation. Is the well-equipped laboratory necessary to "get across" the experiments and significant information that is essential to the training of scientists? How does home-made equipment compare with the purchased equipment as an effective teaching tool? If scientific equipment is necessary, what are the minimum requirements in each area?

Research should be conducted to ascertain what is an equitable teaching load for the science teacher. The school boards and administrators of our high schools must realize that the science teacher is more burdened with different kinds of work than any other teacher. Since most science courses require laboratory work, material, supplies, and equipment must be ordered, designed, and prepared. Also, at the close of each class period the materials must be disassembled, cleaned, and stored.

What provisions are made for the science teacher to plan and execute field trips? Most Kansas high schools are located near excellent field areas that would serve as teaching laboratories. Table VII shows that only 13 per cent of the science teachers of Kansas had any academic preparation in field biology. Further studies should be made to find out what role field trips should play in the study of the sciences.

There is a real need for identification of the child with a special aptitude for science. Since most science programs are geared toward the average student, the gifted children are often overlooked and neglected. What provisions are made to identify and counsel the child with special ability in science? How much time should be allotted the interested stu-

dent to set up individual laboratory projects? What role does the participation in science fairs, Junior Academy of Science, and Science Talent Search play in attracting the good student to the sciences? How much of the science teachers' time should be allotted to the special student?

What are the factors influencing "turnover" among science teachers—limitation on earnings, professional standing, improper placement, and sense of failure due to inadequate training?

What would be the effect of a standardization of teaching combinations in the smaller schools? Would changes in placement procedures reduce the "square peg in a round hole" problem?

RECOMMENDATIONS

The following suggestions may prove helpful to those engaged in the advising of science teachers-in-training:

1. The academic preparation of the science teacher should include a a balanced program in both the physical and biological sciences.
2. Preparation in the subject taught should exceed by a wide margin the six hours minimum now required in Kansas certification requirements.
3. All science teachers should meet the Class A requirements for science teachers. The student in the Class C school is as much entitled to a well-prepared teacher as is the student in the Class A school.
4. Biology teachers should have college preparation in the basic courses of botany, zoology, and field biology. Such subjects as health, hygiene, foods, nutrition, and farm crops are of secondary importance to the prospective biology teacher, and should not satisfy the requirements for science teaching.
5. The general science teacher should be the most broadly trained of any of the science teachers. He should take as many as possible of the following courses: chemistry, physics, botany, zoology, physiology, human anatomy, genetics, geology, astronomy, and microbiology.
6. The prospective science teacher should be urged to extend his training through a fifth year of college work, in order that he may enter his profession adequately prepared for the responsibilities that are his.

SUMMARY

1. The High School Principal's Organization Reports of the 650 accredited senior high schools and the 57 accredited junior high schools were examined for data concerning science teaching in Kansas high schools in 1955-56.
2. The college transcripts of 1144 of the 1177 teachers of science were examined. All college credit in the sciences was recorded.
3. Items recorded concerning each employing school were: location and

name; population of city where located; class of school; type of organization; enrollment; size of last graduating class.

4. Items recorded for each teacher were: name and population of city where teacher graduated from high school; years of experience in present position; total years of teaching experience; school from which the bachelor's degree was received; number of years since graduation; school from which the master's degree was received; number of years since receiving master's degree; science courses taught during 1955-56; major field of interest; junior or senior high school teacher; average grade; age; academic preparation—credit hours in all biological and physical sciences.
5. Forty-six per cent of the science teachers were teaching in schools with an enrollment of less than 100 students.
6. Sixty-three per cent of the teachers were employed in Class A schools.
7. Forty-nine per cent of the teachers were graduates of the five Kansas state schools; 25 per cent were graduates of Kansas independent colleges, and 5 per cent were graduates of Kansas municipal universities. Thirty-nine per cent were graduates of teachers colleges, both within and outside of Kansas.
8. Forty-nine per cent of the science teachers were under 35 years of age.
9. Fifty-three per cent of the science teachers had fewer than nine years of teaching experience. Sixty-one per cent had fewer than five years of experience at their 1955-56 position.
10. Thirty-two per cent of the science teachers had master's degrees. A majority of these master's degrees were in Education.
11. Seventy per cent of the science teachers graduated from Kansas high schools.
12. Two hundred thirteen teachers graduated from high schools located in cities of less than 500. These same schools employ 425 science teachers.
13. One hundred sixteen teachers graduated from high schools located in cities of between 10,000 and 20,000 population. These schools employ only 93 science teachers.
14. One hundred fifty-seven science teachers majored in Biology, 90 in General Science, and 84 in Chemistry. In addition, 169 Physical Education majors, 96 Home Economics majors, 86 Mathematics majors, 51 Industrial Arts majors, and 45 Social Science majors were teaching science.
15. Five hundred thirty-nine science teachers were teaching Biology, 488 General Science, 251 Physics, 225 Chemistry, and 131 Junior High Science.

16. Forty per cent of the science teachers taught from two to four different science courses. Seventy per cent of the science teachers taught either Biology or General Science or both.
17. Forty-five per cent of the science teachers had credit in General Biology, 22 per cent in Genetics, 42 per cent in General Botany, and 29 per cent in Microbiology.
18. Fifty-one per cent of the science teachers had credit in General Zoology, 45 per cent in Human and General Physiology.
19. Fifty per cent of the science teachers had credit in Physics I but only 33 per cent had credit in Physics II.
20. Seventy-one per cent of the science teachers had credit in Chemistry I, 39 per cent in Chemistry II, 27 per cent in Organic Chemistry, and 19 per cent in Qualitative Analysis.
21. Forty-one, or 7.6 per cent, of the biology teachers and 86, or 17.7 per cent, of the general science teachers had no academic preparation in General Biology, Botany, and Zoology.
22. The teachers between the ages of 46 and 50 had more credit in such basic courses as Botany, Zoology, Chemistry I, Chemistry II, and Organic Chemistry than any other age group.
23. The younger science teachers did not have as much credit in Physics and Chemistry as any other age group.
24. The science teachers in Class A high schools had taken a few more science courses than those teaching in Class B, C, and M schools.

LITERATURE CITED

American Association for the Advancement of Science, 1946, Co-operative Committee on Science Teaching, "The Preparation of High-School Science and Mathematics Teachers," *School Science and Mathematics*, XLVI, pp. 107-18.

Anderson, Ross H., 1954, A Study of the Qualifications of the Science Teachers in the Secondary Schools of Oklahoma with Suggestions for Possible Teacher Improvement. Unpublished Dissertation for the Degree Doctor of Education, University of Kansas.

Breukelman, John and Andrews, Ted F., 1956, Offerings and Enrollments in the Secondary School Sciences in Kansas in 1954-55. The Emporia State Research Studies, 4 (3): 1-38.

Burnett, R. Will, 1942, "Teacher Education in Science and Mathematics," *Review of Educational Research*, Vol. 12, pp. 443-50.

Forty-sixth Yearbook of the National Society for the Study of Education, 1947, Part I, Secondary Education in American Schools, p. 276.

Hutson, P. W., 1923, High School Science Teachers: A Study of Their Training in Relation to the Subjects They Are Teaching, *Educational Administration and Supervision*, Vol. IX, pp. 423-38.

Irwin, Frank L., 1938, A Comparative Study of the College Preparation, Teaching Combinations and Salaries of Kansas High School Teachers, (1938). Kan. St. Tchs. Coll. Bull. of Inf., Vol. 18, No. 9, 38 pp.

Koos, L. V. and Clifford Woody, 1919, The Training of Teachers in the Accredited High Schools of Washington, Eighteenth Yearbook of the National Society for the Study of Education, Part I, pp. 213-57.

Lessig, E. Paul, 1942, Facts and Conditions Involved in the Teaching of Biology in Kansas High Schools, Unpublished Master's Thesis, Kan-State Teachers College of Emporia, 92 pp.

Lockard, Gene K., 1946, A Comparative Study of the College Preparation, Teaching Combinations and Salaries of Kansas High School Administrators and Teachers (1946). Kan. St. Tch. Coll. Bull. of Inf., Vol. 26, No. 11, 38 pp.

Maul, Ray C., 1956, "Is the Science Teacher Shortage a Curriculum Factor?," *The Science Teacher*, Vol. XXIII, No. 4, pp. 181-183.

Noll, Victor H., 1939, *The Teaching of Science in Elementary and Secondary Schools*. New York: Longmans, Green and Co., 238 pp.

Peet, Bert W., 1933, "The Training of High School Science Teachers With a Suggested Curriculum," *Science Education*, Vol. XVII, pp. 199-202.

Perry, Edward Nelson, 1952, A Comparison of the Science Offerings and Enrollments Between the Class "A" and Other Public Schools of Kansas. Unpublished Master's Thesis, Kansas State Teachers College of Emporia, 92 pp.

Report of the Southeastern Conference on Biology Teaching, 1955, *The American Biology Teacher*, Vol. 17, No. 1.

Ridgway, C. W., 1931, A Comparative Study of the Training and Teaching Combinations of Kansas High School Teachers. Kansas State Teachers College Studies in Education, No. 5, 31 pp.

Watkins, R. D., and Others, 1937, "Preliminary Report of the Committee of the National Association for Research in Science Teaching on the Training of Science Teachers," *Science Education*, Vol. XXII, pp. 283-293.

Winans, Ada E. and F. C. Jean, 1945, "Educational and Professional Status of Science Teachers in the Public Schools of Colorado," *Science Education*, Vol. 29, pp. 133-136.

Wyatt, W. W., 1948, A Survey of the Qualifications of Teachers of Secondary School Science in Missouri. Unpublished Dissertation for the Degree Doctor of Education, University of Missouri.

The Emporia State Research Studies

Vol. I, No. 1, 1952: Willis Ratzlaff, *The Limnology of Some Roadside Ditches in Chase and Lyon Counties, Kansas.* No. 2, 1952: C. Stewart Boertman, *Apportionment in the Kansas House of Representatives.* No. 3, 1953: John Breukelman and Ted F. Andrews, *Offerings and Enrollments in Secondary School Sciences in Kansas in 1951-52.* No. 4, 1953: George S. Blair, *The Office of County Coroner in Kansas.*

Vol. II, No. 1, 1953: Green D. Wyrick, *The World of Ernest Hemingway.* No. 2, 1953: Ira Everett Welch, *The Comparison of Column Method Versus the Context Method in the Teaching of Spelling.* No. 3, 1954: Jerry P. Leibman, *Press Freedom and Libel as Defined by Kansas Case Law.* No. 4, 1954: Harold Crimmins, *A History of The Kansas Central Railway, 1871-1935.*

Vol. III, No. 1, 1954: Fred W. Grabhorn, *Status of Teachers of Business Subjects in the Secondary Schools of Kansas, 1953-1954;* Billy Lee Fowler, *Turnover of Business Teachers in the Secondary Schools in Kansas, 1952-1953;* Eleanor Patrick Evans, *List of Free Teaching Aids for Typewriting, Bookkeeping, and Shorthand.* No. 2, 1954: Garrett R. Carpenter, *Silkville: A Kansas Attempt in the History of Fourierist Utopias, 1869-1892.* No. 3, 1955: John C. Scafe, *Foreign Language Teaching in Kansas High Schools, 1953-1954.* No. 4, 1955: Richard A. Valyer, *A Proposed Course of Study for Driver Education.*

Vol. IV, No. 1, 1955: Jessie Louise Losey, *A Selected, Annotated List of One-Act Plays for Festival Use.* No. 2, 1955: George E. Thornton, *The Social and Moral Philosophy of Thomas Dekker.* No. 3, 1956: John Breukelman and Ted F. Andrews, *Offerings and Enrollments in Secondary School Sciences in Kansas in 1954-1955.* No. 4, 1956: S. Hull Sisson and Harry Walthall, *An Annotated Bibliography of Theses Accepted for the Master of Science Degree, Kansas State Teachers College, Emporia, 1945 Through 1954.*

Vol. V, No. 1, 1956: Walt Butcher, *Presidential Election Returns for Kansas, 1864-1952.* No. 2, 1956: Alex A. Daughtry, *A Report on the Post-Graduation Activities of the 1955 Kansas High School Graduates.* No. 3, 1957: Carl W. Prophet, *Seasonal Variations and Abundance of Cladocera and Copepoda and Some Physical-Chemical Conditions of the Fall and Verdigris Rivers in Wilson and Montgomery Counties, Kansas*: Claire L. Schelske, *An Ecological Study of the Fishes of the Fall and Verdigris Rivers in Wilson and Montgomery Counties, Kansas.* No. 4, 1957: William C. Tremmel, *The Social Concepts of George Herbert Mead.*

Vol. VI, No. 1, 1957: John M. Matthews, *Sang De Boeuf: Its Chinese Historical References and Local Reduction Experiments in Electric Firing Kilns.* No. 2, 1957: Weldon N. Baker and Merle E. Brooks, *Background and Academic Preparation of the Teachers of Science in the High Schools of Kansas 1955-1956.*