

ACADEMIC PREPARATION IN SCIENCE OF CHEMISTRY
TEACHERS IN THE KANSAS HIGH SCHOOLS
1962-1963

by

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A MASTER'S REPORT

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THE PROBLEM AND DEFINITIONS OF TERMS USED

The concern for better preparation of teachers in the field of science and mathematics has been growing during the last several years. This study was made to investigate the academic preparation of chemistry teachers in Kansas.

THE PROBLEM

Statement of the problem. It was the purpose of this study to determine (1) the number of college credits in chemistry and in the science field of chemistry teachers in Kansas; and (2) the relationship between academic preparation of teachers in chemistry and the size of the school in which they teach.

Need for the study. Professional educators, industrialists, government policy-makers, college curriculum planners, and other civic-minded groups have been concerned about the problem of educating qualified science teachers for many years. How many chemistry teachers in Kansas exceed the minimum academic certification requirements?

Comparative studies of the college preparation, teaching combinations, and salaries of Kansas high schools were made by Ridgway¹ (1931),

¹C. W. Ridgway, "A Comparative Study of the Training and Teaching Combinations of Kansas High School Teachers," Kansas State Teachers College Studies in Education, No. 5, 1-31.

Irwin² (1938), and Lockard³ (1946). These investigators found that a large number of science teachers were insufficiently prepared for the science they were teaching, especially in the small high schools.

The years following World War II were marked by a variety of intensive programs designed to upgrade American science education. Representative of such programs were those of the National Science Foundation (science and mathematics teacher institutes), Ford Foundation (filmed courses in high-school physics and chemistry), and the American Association for the Advancement of Science (Science Teaching Improvement Program). In late 1957, a Russian Sputnik streaked into orbit and intensified the concern for improvements in the academic preparation of science teachers.

An attempt is made in this study to provide evidence to prove or refute many common generalizations about the preparation of secondary school chemistry teachers in the science field. The results of a study of this type should also prove helpful in the evaluation of curricula of both large and small high schools.

²Frank L. Irwin, "A Comparative Study of the College Preparation, Teaching Combinations, and Salaries of Kansas High School Teachers, (1938)," Kansas State Teachers College Bulletin of Information, XVIII, 1-33.

³Gene K. Lockard, "A Comparative Study of the College Preparation, Teaching Combinations, and Salaries of Kansas High School Administrators and Teachers, (1946)," Kansas State Teachers College Bulletin of Information, XXVI, 1-36.

DEFINITIONS OF TERMS USED

Part time science teacher. This person is employed to teach classes of physics, chemistry, earth science, general science, physical science or biology for a fraction of the school day.

Full time science teacher. This person is employed to teach classes of physics, chemistry, earth science, general science, physical science or biology for the entire school day.

Full time chemistry teacher. This person is employed to teach classes of chemistry for the entire school day.

Teaching area or science field. The summation of all college credits earned in chemistry, physics, biology, and earth science constitute the teaching field of science. Credits in mathematics are not included in the science field.

Credits. The number of semester hours earned during college preparation.

Qualification to teach. This is based upon the requirements of the Kansas State Board of Education as stated in the Certification Handbook of July 1, 1961. A minimum of twenty-four semester hours in the field of science with six semester hours in the subject is required.⁴

⁴Kansas State Board of Education, Certification Handbook, (Topeka: State Board of Education, 1961), p. 59.

ORGANIZATION OF REMAINDER OF THE REPORT

The main sections which are included in the remainder of this report are as follows: a review of the literature on the preparation of chemistry teachers and college programs for the preparation of chemistry teachers; procedure used and analysis of results; and summary and conclusions.

REVIEW OF THE LITERATURE

Much has been written about the subject-matter preparation of high school science teachers and dealing with problems in preparing science teachers properly, especially teachers for the small high school. Changes in state certification laws may not always come quickly, thus studies concerning the preparation of chemistry teachers would be helpful in evaluating the preparation of chemistry teachers.

LITERATURE ON THE PREPARATION OF CHEMISTRY TEACHERS

In 1957 Baker and Brooks studied the background and academic preparation of the teachers of science in the high schools of Kansas. The report was based on data taken from the 1955-56 High School Principals Organizational Reports on file at the State Department of Public Instruction and from the transcripts on file at the same department. The transcripts of 1144 of these science teachers were studied, and the credit hours in each subject in the sciences recorded.

The authors arbitrarily chose what they considered to be ten basic science courses that are essential for the effective teaching of high school science. In the "basic ten" courses, the chemistry teachers had the most credit. Ninety-six per cent had Chemistry I, eighty per cent Chemistry II, and fifty-six per cent Organic Chemistry. Seventy-one per cent had Physics I, fifty-five per cent Physics II, and fifty-three per cent Zoology. They also concluded that science teachers in Class A high schools had taken a few more science courses than those teaching in Class B, C, and M schools. Thirty-two per cent of the science

teachers had master's degrees.⁵

Pella (1958) analyzed Wisconsin Department of Education data on the academic training of 261 chemistry teachers. Academic preparation in chemistry was included by 96.2 per cent of the teachers of chemistry. The mean number of credits in science exclusive of mathematics earned by the chemistry teacher was 43.3. The mean for the part time science teacher was 40.1 credits and for the full time science teacher 48.8 credits. The average teacher of chemistry had 18.5 credits of chemistry in his academic preparation. The part time science teacher had 17.6 credits and the full time science teacher had 19.8 credits as an average. Schools with more than two hundred pupils enrolled generally had teachers who were slightly better prepared academically in chemistry and in the broad area of science. The average teacher of chemistry had spent time equivalent to about one half of a baccalaureate degree studying science and mathematics.⁶

A large-scale study of science and mathematics teaching by the National Education Association Research Division (1959) revealed that among 5,200 science teachers questioned, about half (49.3 per cent) were employed as full time teachers of science. The most disconcerting

⁵Weldon N. Baker and Merle E. Brooks, "Background and Academic Preparation of the Teachers of Science in the High Schools of Kansas 1955-56," The Emporia State Research Studies, VI (December, 1957), 1-40.

⁶Milton O. Pella, "The Nature of the Academic Preparation in Science of Wisconsin High School Teachers of Physics, Chemistry, Biology, and General Science," Science Education, XLII (March, 1958), 123-128.

fact reported was that more than five per cent of all teachers had only nine or fewer credits in science, and 0.3 per cent had no training in science at all. Between 21 and 22 per cent had fewer than twenty hours in the science field. "These facts do not consider the appropriateness of the person's science background to his current assignment, and thus present a more optimistic view than is warranted."⁷

Gardner and Richardson (1960) analyzed Ohio State Department of Education data for the school year 1957-58 concerning the academic training of 603 teachers in chemistry. Seven per cent had no college training in the teaching area, twenty-three per cent had 1-14 credits, forty-six per cent had 15-30 credits, and twenty-five per cent had over thirty credits in the teaching area. Twenty-eight per cent of the teachers of chemistry had fewer than fifteen credits of chemistry, which was required for certification. The average teacher of chemistry had 22.8 credits in chemistry and forty-nine credits in the teaching area.⁸

In an unpublished Master's report Smith (1962) obtained a sample of 118 schools of Kansas and found that the mean number of hours of chemistry for all the chemistry teachers was 23.8 semester hours of preparation. Four and three-tenths per cent of the teachers sampled had less than six hours preparation in chemistry.⁹

⁷Herbert A. Smith and Guy B. Hogman, "The Academic and Professional Preparation of Teachers of Science," Review of Educational Research, XXXI (June, 1961), 291.

⁸Marjorie Gardner and John S. Richardson, "The Teachers of Science in Ohio Senior High Schools," Educational Research Bulletin, XXXIX (March, 1960), 65-71.

⁹James A. Smith, "Academic Preparation of Kansas High School Teachers in Science, Social Studies, and Physical Education for the School Year 1960-1961," (unpublished Master's report, Kansas State University, Manhattan, 1962), p. 22-23.

LITERATURE ON COLLEGE PROGRAMS FOR THE
PREPARATION OF CHEMISTRY TEACHERS

A study (1961) sponsored by the National Association of State Directors of Teacher Education and Certification in cooperation with the American Association for the Advancement of Science, was concerned with the nature and amount of subject-matter concentration required in each teacher education program. No attempt was made to set up programs to fit the many types of small secondary schools.

A systematic study of chemistry with sufficient preparation for the later pursuit of graduate work in chemistry was recommended for the high school teacher of chemistry. An adequate basic study in physics, mathematics, and biology was included. The program of a chemistry teacher should include training in methods, especially in the design of experiments, and the development and presentation of demonstrations. The chemistry teacher should be prepared to function competently in curriculum improvement courses such as the Chemical Bond Approach Project and the Chemical Education Materials Study.¹⁰

In 1960 the American Association for the Advancement of Science Cooperative Committee on the Teaching of Science and Mathematics recommended the adoption of a background common to all of the science teachers preparation (not including preparation for mathematics teaching). The recommendation was as follows in semester hours: biology six; chemistry eight; physics eight; related science three; and mathematics

¹⁰Guidelines for Preparation Programs of Teachers of Secondary School Science and Mathematics, A Report Prepared by the National Association of State Directors of Teacher Education and Certification and the American Association for the Advancement of Science (Washington, D.C.: A.A.A.S., 1961), p. 1-16.

six; for a total of thirty-one semester hours. In addition to the "common background" a chemistry teacher should have an additional twenty hours of preparation in chemistry. This would make a total of twenty-eight hours of chemistry preparation and forty-five hours in the teaching area.

Because there was so much in common among the five curricula in science, it was quite practical for the prospective teacher to qualify in at least two of the five science areas involved in this report. This was considered an ideal preparation for the modern high school teacher of science, but the program does not prepare the teacher for more advanced study.¹¹

By questionnaire, Novak and Brooks (1959) recorded the judgement of 196 Kansas high school teachers of science as to the preparation necessary to teach high school science. They found the teachers' recommendations modest in terms of required college preparation but that even their modest recommendations exceeded certification requirements. "Many science teachers are themselves satisfied with little or no basic college course work in science subjects taught in the high school."¹²

For high school chemistry one hundred per cent of 159 respondents indicated Chemistry I was "essential", eighty per cent marked the course as an absolute minimum. Ninety per cent of the teachers indicated Chemistry II was "essential" and sixty-eight per cent regarded the course as an absolute minimum.¹³

¹¹"Preparation of High School Science Teachers," Science, CXXXI (April, 1960), 1024-1029.

¹²Joseph D. Novak and Marle E. Brooks, "College Preparation of Science Teachers," Science Teacher, XXVI (November, 1959), 473.

¹³Ibid., 473-477.

PROCEDURES USED

This study was based on data concerning the secondary school teacher of chemistry in Kansas and was obtained from the 1962-63 High School Principals Organizational Reports on file at the State Department of Public Instruction. The writer accepted the accuracy of the principal's judgement in recording the semester hours of credit for the teachers in the proper place on the organizational reports. In a few cases when the number of credits were not clear, the transcripts on file at the State Department of Public Instruction were studied.

The items recorded about each teacher were: number of credits in chemistry, number of credits in teaching area, last academic degree earned, and whether the teacher was a full time science teacher, part time science teacher, or full time chemistry teacher. The size of the school enrollment was also recorded.

A total of 440 teachers were teaching one or more chemistry courses in the secondary schools of Kansas. The writer was unable to determine the amount of academic preparation of seven teachers of chemistry, thus 433 teachers were studied.

ANALYSIS OF RESULTS

Table I shows the distribution of the size, number of teachers, and chemistry offerings of the schools studied. Thirty-eight per cent of the teachers of chemistry taught in schools with less than one hundred students or sixty-four per cent of the chemistry teachers taught in schools with less than two hundred students. Eighty-four schools did not offer chemistry during the 1962-63 school year but offered the course every two years. Seventy schools did not offer chemistry in their high school curriculum.

There was a relationship between the size of school and number of Master's degrees earned as shown in Table II. In schools with enrollments under one hundred twenty-one per cent of the teachers earned Master's degrees. This was below the thirty-two per cent average for the entire group of 433 teachers. An increase in percentage earning Master's degrees increased as the school size increased indicating that larger schools employed teachers who were better prepared academically. Fifty-five per cent of the teachers of chemistry in schools with over 1,500 students had earned a Master's degree.

As the size of the school increased the average number of college credits in chemistry and in the teaching field increased as illustrated in Figure 1. The average chemistry teacher in a school with less than one hundred students had fifteen credits of preparation in chemistry and forty-four credits in the teaching area. The average chemistry teacher in a school over 1,500 had thirty-eight credits of chemistry and seventy-three credits in the science teaching field.

TABLE I

DISTRIBUTION OF SIZE, NUMBER OF TEACHERS, AND
CHEMISTRY OFFERINGS OF THE SCHOOLS STUDIED

Size of school	Number of schools	Number of chemistry teachers	Per cent of total teachers*	Chemistry not offered	Chemistry offered on alternate years
Under 100	301	164	38	69	68
101-200	129	113	26	1	15
201-300	49	49	11	0	1
301-750	59	59	14	0	0
751 or more	35	48	10	0	0
Total	573	433	-	70	84

*This figure was computed as follows: number of chemistry teachers divided by total number of chemistry teachers (433) studied. For example, $164 \div 433 = .38$ or 38 per cent.

TABLE II
DISTRIBUTION OF NUMBER OF TEACHERS WITH MASTER'S DEGREES

Size of school	Number of teachers	Number earned M.S.	Per cent earned M.S.
Under 100	164	34	21
101-200	113	37	33
201-300	49	21	43
301-400	24	8	33
401-500	13	5	39
501-750	22	8	36
751-1000	15	6	40
1001-1500	13	10	77
1501 or more	20	11	55
Total	433	140	Average 32

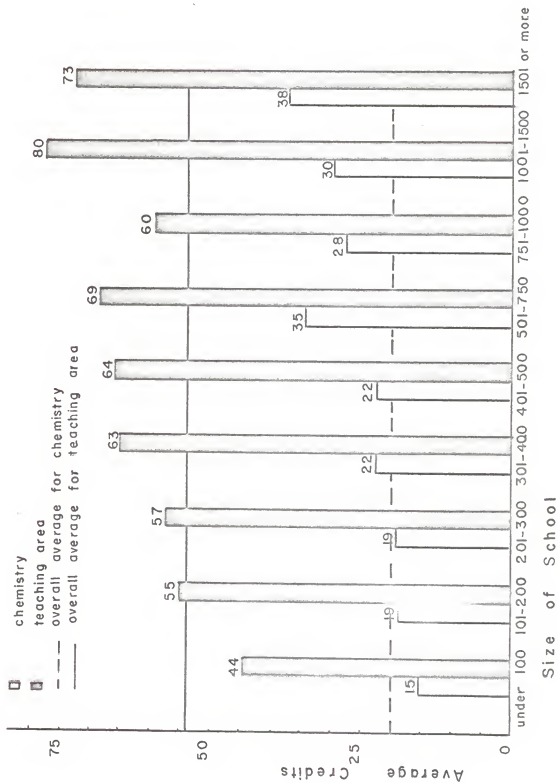


FIGURE 1.

THE AVERAGE NUMBER OF CREDITS IN CHEMISTRY AND TEACHING AREA VERSUS SIZE OF SCHOOL

In Kansas the average teacher of chemistry had twenty credits of preparation in chemistry and fifty-four credits in the science teaching field. About one in three chemistry teachers had earned a Master's degree.

The data with regard to the number of part time and full time science teachers and full time chemistry teachers are presented in Table III. This table also presents some conditions that exist when over half of the high schools have enrollments of less than one hundred students. Eighty-seven per cent of the chemistry teachers employed by schools with an enrollment under one hundred were teaching courses that were not included in the science teaching area. Courses taught by the chemistry teachers included: art, music, chorus, physical education, mathematics, English, and social studies. In addition to a variety of courses, some chemistry teachers had administrative responsibilities. In schools with enrollments from 301-400 fifty per cent were part time science teachers. As the school enrollment increased the number of part time science teachers decreased and more teachers taught chemistry the entire school day. In schools over 1,500 students seventy-five per cent were full time chemistry teachers. Fifty-eight per cent of the chemistry teachers taught subjects outside the teaching area, thirty-six per cent were full time science teachers, and six per cent were full time chemistry teachers.

A comparison between the preparation of full time and part time science teachers and full time chemistry teachers is presented in Table IV. The table shows that the full time science teacher was slightly better prepared academically in chemistry than the part time science teacher. The average part time science teacher had seventeen

TABLE III

DISTRIBUTION OF THE NUMBER OF PART TIME AND FULL TIME SCIENCE TEACHERS
AND FULL TIME CHEMISTRY TEACHERS

Size of school	Number of		Percent of	
	PS	FS	PS	FS
Under 100	143	21	87	13
101-200	58	55	51	49
201-300	22	27	45	55
301-400	12	12	50	50
401-500	5	8	39	62
501-750	7	10	32	45
751-1000	2	11	13	73
1001-1500	1	8	8	62
1500 or more	2	3	10	15
Total	252	155	Average 58	36

PS = Part time science teacher

FS = Full time science teacher

FC = Full time chemistry teacher

TABLE IV

COMPARISON BETWEEN THE PREPARATION OF FULL TIME AND PART TIME
SCIENCE TEACHERS AND FULL TIME CHEMISTRY TEACHERS

Size of school	Average credits earned in chemistry		Average credits earned in teaching area	
	PS	FS	PS	FS
Under 100	15	15	43	53
101-200	18	20	46	64
201-300	23	17	53	60
301-400	24	20	55	71
401-750	22	30	52	74
751 or more	-	29	-	73
Average	17	21	46	64
				73

PS = Part time science teacher

FS = Full time science teacher

FC = Full time chemistry teacher

credits of chemistry and the full time science teacher had twenty-one credits of chemistry. The full time chemistry teacher was much better prepared in chemistry (averaged 37 credits) than the part time and full time science teacher. The full time science teacher was much better prepared in the science teaching area with an average of sixty-four credits; and the part time science teacher averaged forty-six hours of preparation in the teaching area. The full time chemistry teacher had an average of seventy-three credits in the teaching area.

The data called direct attention to the fact that the part time science teacher was below the average chemistry teacher in regard to the amount of academic preparation in chemistry and in the teaching area. The range 12-30 (Appendix A) for the full time chemistry teacher revealed that a few teachers were very low in preparation of chemistry too.

Observations revealed that all the full time chemistry teachers had more than ten credits in chemistry but four of the teachers had fifteen credits or less in chemistry or fifteen per cent.

Table V presents the preparation of chemistry teachers in schools of various sizes. The majority of the chemistry teachers with five hours or less of chemistry were part time science teachers in schools with enrollments under one hundred. Three per cent of the chemistry teachers had under six hours of college chemistry. In the State of Kansas, in the 1962-63 school year, six hours of college chemistry were required for certification to teach the subject chemistry. Ninety part time science teachers and forty full time science teachers had ten credits or less of chemistry. This made a total of 130 chemistry

TABLE V

PREPARATION OF CHEMISTRY TEACHERS ACCORDING TO SCHOOL SIZE

Size of school	5 credits or less chemistry		10 credits or less chemistry		Under 25 hours in teaching area	
	PS	FS	PS	FS	PS	FS
Under 100	11	0	66	9	18	-
101-200	1	1	17	16	4	-
201-300	-	-	3	9	-	-
301-400	-	-	1	2	-	-
401-750	-	-	3	1	-	-
750 or more	-	-	0	3	-	1
Total	12	1	90	40	22	1

PS = Part time science teacher

FS = Full time science teacher

teachers or thirty per cent of the chemistry teachers had ten hours or less of college chemistry. The majority of the teachers with less than twenty-five credits in the teaching area were teaching in schools with enrollments under one hundred. Five per cent of the chemistry teachers of Kansas had under twenty-five credits in the teaching area. In the 1962-63 school year, twenty-four semester hours in the science field were required for certification in Kansas.

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the number of college credits in chemistry and in the science field of chemistry teachers in Kansas; and to determine the relationship between academic preparation of teachers in chemistry, and the size of the school in which they teach. Data concerning the secondary school chemistry teacher in Kansas was obtained from the 1962-63 High School Principals Organizational Reports on file at the State Department of Public Instruction. A total of 433 chemistry teachers were studied.

Data gathered from the study of chemistry teachers in Kansas are summarized in the following statements:

(1) Thirty-eight per cent of the teachers taught in schools with less than one hundred students or sixty-four per cent taught in schools with less than two hundred students.

(2) Seventy schools did not offer chemistry in their high school curriculum and eighty-four schools offered the course every two years.

(3) There was a relationship between the size of school and the teacher's academic preparation. The number of credits in chemistry increased from fifteen to thirty-eight and the credits in the science field from forty-four to eighty as the size of the school increased from under one hundred to over 1,500 students.

(4) The average teacher had twenty credits of preparation in chemistry and fifty-four credits in the science teaching area.

(5) About one in three chemistry teachers had earned a Master's degree.

(6) Fifty-eight per cent of the teachers taught subjects outside the teaching area, thirty-six per cent were full time science teachers, and six per cent were full time chemistry teachers.

(7) The part time science teacher averaged seventeen credits, full time science teacher twenty-one, and the full time chemistry teacher thirty-seven in chemistry.

(8) The part time science teacher averaged forty-six credits, full time science teacher sixty-four, and the full time chemistry teacher seventy-three credits in the teaching area.

(9) Three per cent of the teachers, the majority of which were employed by schools under one hundred, had five hours or less of chemistry.

(10) Five per cent of the teachers had under twenty-five credits in the teaching area. Most of them were teaching in schools with enrollments under one hundred.

(11) Fifteen per cent of the full time chemistry teachers had fifteen credits or less in chemistry.

(12) A total of 130 chemistry teachers or thirty per cent of the chemistry teachers had ten hours or less of college chemistry.

From this study it can be concluded that a direct relationship existed between academic preparation of chemistry teachers and the size of school in which they taught. It was found that as the schools increased in size the number of credits of preparation in chemistry and the teaching area also increased. The study revealed that large and small high schools usually employed chemistry teachers with academic preparation in excess of the requirements of the Kansas State Department of Public Instruction.

The average chemistry teacher of Kansas had twenty semester hours of preparation in chemistry and fifty-four credits in the science teaching area. The results of this study show a need in the State of Kansas to raise the level of preparation of chemistry teachers.

The level of teacher preparation was higher than expected by the writer. It is probable that if a similar study were to be made in the future the level of academic preparation would be even higher. Science workshops sponsored by the National Science Foundation, improvements of college curriculums in teacher preparation, school district reorganization, the National Education Defense Act, and others are working toward improvement of education and preparing better chemistry teachers.

This study dealt with preparation in the subject and teaching area. Similar studies dealing with academic preparation at various teacher-training institutions would be helpful.

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APPENDIX

APPENDIX A: RANGE OF CREDITS IN TABLE IV

Size of school	Credits in chemistry		Credits in teaching area	
	PS	FC	PS	FC
Under 100	5-58	8-30	8-121	30-81
101-200	5-50	5-89	24-118	26-133
201-300	7-66	8-44	25-101	33-89
301-400	10-60	8-48	31-112	44-104
401-750	8-47	7-55	25-80	34-128
751 or more	-	8-85	-	24-118
				35-123

PS = Part time science teacher

FS = Full time science teacher

FC = Full time chemistry teacher

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The purpose of this study was to determine the number of college credits in chemistry and in the science field of chemistry teachers in Kansas; and the relationship between academic preparation of teachers in chemistry and the size of the school in which they teach. The entire study was based on analysis of the total number of college hours in chemistry and the science field.

The High School Principals Organizational Reports for 1962-1963 were used to obtain the total number of semester hours of preparation. A total of 433 high school chemistry teachers were studied.

Thirty-eight per cent of the teachers taught in schools with less than one hundred students or sixty-four per cent taught in schools with less than 200 students. Seventy schools did not offer chemistry in their high school curriculum and eighty-four schools offered the course every two years.

The average chemistry teacher had twenty semester hours of preparation in chemistry and fifty-four semester hours in the science field. About one in three chemistry teachers had earned a Master's degree.

This study indicated that as the schools increased in size the number of semester hours that teachers earned in chemistry and the teaching area increased. Fifty-eight per cent of the teachers taught subjects outside the teaching area, thirty-six per cent were full time science teachers, and six per cent were full time chemistry teachers. The part time science teacher averaged seventeen semester hours, full time science teacher twenty-one, and full time chemistry teacher thirty-seven hours in chemistry. The part time science teacher averaged forty-

six semester hours, full time science teacher sixty-four, and the full time chemistry teacher seventy-three hours in the teaching field. Eighty-seven per cent of the chemistry teachers employed by schools under one hundred students were part time science teachers. Seventy-five per cent of the chemistry teachers in schools with an enrollment over 1,500 were full time chemistry teachers.

In analyzing the relationship between state certification requirements and the size of school, it was found that chemistry teachers in the larger schools more adequately met or exceeded state certification requirements. Chemistry teachers employed at schools with enrollments under one hundred averaged fifteen hours of college chemistry and forty-four hours in the science field. Three per cent of the Kansas chemistry teachers had less than six semester hours of chemistry and five per cent had under twenty-five hours in the science field. The majority of them were employed in schools with enrollments under one hundred. Fifteen per cent of the full time chemistry teachers had fifteen hours or less in chemistry. A total of 130 chemistry teachers or thirty per cent of the Kansas chemistry teachers had ten hours or less of college chemistry.

This study showed that the over-all academic preparation of Kansas chemistry teachers is not particularly low. However, there is a definite need in the State of Kansas to raise the level of preparation of chemistry teachers especially in the small schools.