DOCTORAL DISSERTATION SERIES

PUBLICATION: 5993

AUTHOR: Theodore Alvin Nelson, Ph. D., 1953
University of Illinois

# TITLE: COMPETENCIES DESIRABLE FOR BEGINNING SCIENCE TEACHERS AS VIEWED BY ADMINISTRATORS AND SCIENCE TEACHERS IN THE STATE OF ILLINOIS

University Microfilms, Ann Arbor, Michigan

# COMPETENCIES DESIRABLE FOR BEGINNING SCIENCE TEACHERS AS VIEWED BY ADMINISTRATORS AND SCIENCE TEACHERS IN THE STATE OF ILLINOIS

BY

THEODORE ALVIN NELSON

B.S., Knox College, 1928
M.S., University of Illinois, 1937

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN EDUCATION
IN THE GRADUATE COLLEGE OF THE
UNIVERSITY OF ILLINOIS, 1953

URBANA, ILLINOIS

# UNIVERSITY OF ILLINOIS

## THE GRADUATE COLLEGE

January 17, 1953

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY THEODORE ALVIN NELSON

ENTITLED COMPETENCIES DESIRABLE FOR BEGINNING SCIENCE TEACHERS AS VIEWED BY ADMINISTRATORS AND SCIENCE TEACHERS IN THE STATE OF ILLINOIS

BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN EDUCATION

H. Wm Brunetti
In Charge of Thesis

W. L. Bone
Head of Department

Recommendation concurred in†

H. Wm Brunetti
Herbert
John C. Beckar Jr
Edward F. Potthoff
B Othanel Smith

Committee on Final Examination†

† Required for doctor's degree but not for master's.

5M—11-51—48672

In order to point up the relation between the teacher-training institution and the job for which it is providing training, this inquiry has attempted to determine the competencies believed desirable or necessary for the beginning science teacher in his first few years of work. The study has sought to determine: (1) the training these teachers had in the fields of science and education; (2) what duties they have been called upon to perform in teaching science; and (3) their duties with respect to other activities of their schools. It also attempted to find out wherein these beginning science teachers have felt themselves inadequate to meet the demands of their jobs, and what opinions they held about the quality of their training in the light of actual experience on the job.

In addition, this inquiry undertook to learn what school administrators have been looking for in the training of the science teachers they must employ to meet the needs of their schools and communities.

Two separate inventories were constructed for gaining this information. One was sent to every third administrator on the mailing list of the University of Illinois Mailing Service and the other was sent to every science teacher in the state who had taught one, two, or three years.

Responses were received from approximately seventy percent of the administrators and forty percent of the beginning science teachers.

The data collected in the study suggested the following recommendations be made for science teacher training:

1. A minimum of 60 semester hours of science subject matter should be required. This subject matter should be so divided that the prospective

science teacher takes first courses of from six to eight semester hours each in physics, chemistry and earth science and twelve semester hours in biology. This should be followed by second courses of from six to eight semester hours in three of these subjects and a third course of six to eight semester hours in one of these subjects. The science teacher should have a strong major in one science subject supported if possible by a second major in another science subject.

2. The student teaching should be at least one semester in duration and should give the student every opportunity to participate in all the duties of a teacher in the school. This student teaching should be done in a public school under the supervision of an expert science teacher.

3. In the training about boys and girls the student teacher should have courses in general psychology, psychology as applied to education, psychology as applied to adolescents, psychology of personality and social adjustment, guidance and counseling, remedial programs of the school and interpretation of various diagnostic instruments of the school.

These courses should be designed to prepare teachers to handle the problems they will encounter constantly in dealing with boys and girls on the secondary level.

4. The prospective science teacher should have courses in the organization of the secondary school and the place of science in this organization. A course in curriculum development and a course in science teaching are also highly desirable.

5. In the area of the humanities, the prospective teacher should have experiences in composition and speech as well as opportunities to acquire knowledge of history, economics, sociology and anthropology.

6. Other courses in the training program will include mathematics and such elective courses as may seem proper and advisable.

On the basis of 128 semester hours of training such a program may line up as follows:

| | | |
|---|---|---|
| Science | 60-64 | semester hours |
| Education | 27 | " " |
| Humanities | 12 | " " |
| Mathematics | 6-9 | " " |
| Total | 105-112 | semester hours |
| Electives | 23-16 | " " |

This training program plus practice teaching would generally require five years of study.

# TABLE OF CONTENTS


| CHAPTER | | PAGE |
|---|---|---|
| I. | THE NATURE OF THE PROBLEM | 1 |
| | A Statement of the Problem | 1 |
| | The Need for a Study of Science Teacher Competencies | 1 |
| | Educational Benefits Which May Result | 1 |
| | Present Conditions and Problems | 2 |
| | Definition of Terms | |
| | Beginning Science Teachers | 11 |
| | School Administrators | 12 |
| | Competencies | 12 |
| | Basic Assumptions Underlying the Study | 12 |
| II. | INSTRUMENTS AND TECHNIQUES | 14 |
| | Populations Used | 14 |
| | Construction and Administration of the Inventories | 14 |
| | The Administrators' Inventory | 14 |
| | The Teachers' Inventory | 15 |
| | Response to the Inventories | 17 |
| | Responses from the Administrators | 17 |
| | Responses from the Science Teachers | 18 |
| | Limitations of the Study | 19 |
| III. | WHAT ADMINISTRATORS WANT IN THE TRAINING OF SCIENCE TEACHERS FOR ILLINOIS HIGH SCHOOLS | 22 |
| | Training in Classroom Techniques | 23 |
| | Training for Professional Responsibilities | 25 |

CHAPTER PAGE

Training in the Application of Science to General Education . . . . . 27

Training for Understanding Boys and Girls . . . . . 30

Other Aspects of Professional Training . . . . . 32

Training in the Subject Matter of Science . . . . . 35

Patterns of Student Teaching . . . . . 40

IV. A COMPARISON OF RESPONSES FROM DIFFERENT SEGMENTS OF THE ADMINISTRATIVE POPULATION . . . . . 43

Comparison of Administrator Responses with Respect to Size of Schools . . . . . 43

Comparison of Administrator Response with Respect to Type of School . . . . . 50

Implications of the Comparisons in This Study . . . . . 53

V. THE TRAINING OF BEGINNING SCIENCE TEACHERS IN THE STATE OF ILLINOIS . . . . . 55

The Teachers in the Study . . . . . 55

Where They Were Trained . . . . . 55

Size of Schools Where They Were Employed . . . . . 55

Formal Training . . . . . 56

Training in the Subject Matter of Science . . . . . 60

The Beginning Physics Teachers . . . . . 60

The Beginning Chemistry Teachers . . . . . 63

The Beginning Biology Teachers . . . . . 65

The Beginning General Science Teachers . . . . . 69

CHAPTER PAGE

VI. THE WORK PERFORMED BY THE BEGINNING SCIENCE TEACHERS . . . . . 73

Combinations of Subjects Taught . . . . . 73

The Duties of Science Teachers . . . . . 77

Work in Classroom Techniques . . . . . 77

Work Involving Professional Responsibilities . . . . . 80

Work in the Area of General Education . . . . . 81

Understanding Boys and Girls . . . . . 83

Other Responsibilities . . . . . 86

Summary . . . . . 88

VII. THE OPINIONS OF BEGINNING SCIENCE TEACHERS ABOUT THEIR TRAINING, ABOUT THEIR JOBS, AND OF THEMSELVES AS TEACHERS . . . 90

The Teachers Judge Their Subject-Matter Preparation . . . . 90

Some Comments Made by the Teachers on Their Subject-Matter Preparation . . . . . 95

The Teachers Judge Their Professional Education . . . . . 96

Their Practice Teaching . . . . . 96

Preparation for Understanding Boys and Girls . . . . . 99

Some Comments from the Beginning Science Teachers about Their Professional Training . . . . . 101

The Teachers View Their Education for Life in Contemporary Society . . . . . 102

How Beginning Science Teachers Judged Their Schools and Their Success in Meeting the Demands of Their Work . . . . . 110

The Teachers Appraise Their Schools . . . . . 110

The Teachers State the Aims of Their Instruction . . . . 113

CHAPTER PAGE

VIII. SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS . . . . . 118

Summary of the Findings and Their Implications . . . . . 118

Courses Taught by Beginning Science Teachers . . . . . 119

Subject-Matter Training of Beginning Science Teachers . 120

Training in Education . . . . . 121

The Work of the Beginning Science Teacher . . . . . 122

Teaching Objectives . . . . . 122

Work Done by the Responding Teachers . . . . . 124

The Teacher's Job as Seen by the Administrator . . . . . 125

How Beginning Teachers View Teacher Training Programs . 127

General Conclusions . . . . . 129

Recommendations for Programs of Training High School Teachers of Science . . . . . 131

Science Subject Matter . . . . . 131

Student Teaching . . . . . 137

Training About Boys and Girls . . . . . 138

Other Courses in Education . . . . . 142

Communication Skills and the Humanities . . . . . 144

Other Courses in the Training Program . . . . . 146

BIBLIOGRAPHY . . . . . 148

# ACKNOWLEDGMENT

The writer wishes to express his sincere appreciation to Vernon L. Nickel, Superintendent of Public Instruction in the State of Illinois, for permitting the use of his files for the purpose of locating the beginning science teachers in the secondary schools.

He further acknowledges the great help of the numerous administrators and beginning science teachers of the state who gave generously of their time in filling out the questionnaires that furnished the data necessary for this study.

The writer is greatly indebted to Dr. Harold Hand and Dr. B. O. Smith, members of his advisory committee, who offered much guidance and constructive criticism during the entire study.

Special thanks are due Dr. R. Will Burnett, his adviser, who so patiently and ably offered helpful suggestions and encouraged the writer throughout the study. With the help of these this study was made possible.

# CHAPTER I

## THE NATURE OF THE PROBLEM

In this study an attempt was made to determine what competencies are desired of science teachers in the high schools of Illinois. In the past the competence of teachers in the fields of science has been measured, to a large extent, by the number of semester hours of training completed. But by today's standards, which seem to define more broadly the role of a teacher in school and community life, subject-matter competence would appear to be only one of many competencies necessary for the science teacher's success.

### A. A STATEMENT OF THE PROBLEM

This inquiry has attempted to determine the competencies desirable or necessary for the science teacher in his first years of work as seen by (1) the beginning science teachers of Illinois and (2) the administrators who hire them. The study has sought to determine: (1) the training these teachers have had in the fields of science and education; (2) the duties they have been called upon to perform in teaching science; (3) their duties with respect to other activities of their schools; (4) wherein these beginning science teachers have been inadequate to meet the demands of their jobs; and (5) what opinions they and their employing officers hold about the training of science teachers in the light of actual job experience.

### B. THE NEED FOR A STUDY OF SCIENCE TEACHER COMPETENCIES

Educational Benefits which May Result. A study of this kind is intended to produce findings which will point to direct and realizable educational benefits. A consideration of those who may ultimately derive profit from this inquiry

suggests the scope of its possible significance. It is believed that the information gained from this investigation may well be applied to the advantage of (1) teacher training institutions; (2) prospective science teachers; (3) the schools and the administrators who will employ the teachers; (4) the young people who will learn from these teachers; and, ultimately, (5) the communities served by these teachers.

Present Conditions and Problems. There is often strong disagreement among faculty members in teacher training institutions as to the nature of the preparation which will best fit prospective science teachers for their future work. Staff members from the various subject matter fields often fail to find a common ground with staff members from the education departments on questions of emphasis, degree of specialization, variety and extent of coverage of science and other fields necessary to the student teacher's program. At least some of this disagreement may result from lack of information about the kinds of problems which confront the beginning science teacher on his job. Therefore, it is believed that all departments concerned with teacher training would profit from a greater knowledge of what is actually expected of the novice teachers they are sending into the field.

Insofar as this lack of information contributes to a poorly planned and poorly coordinated program of preparation, the beginning teacher is handicapped in meeting his first professional problems. If the science staff has formulated one kind of training program, based on its conception of the elements of study and experience requisite to the best preparation of a high school teacher, and the education faculty has recommended a program fundamentally different in emphasis and content, the novice teacher coming out of such a training institution will be understandably confused. He may doubt his own teaching abilities as he questions the adequacy of the training which supposedly shaped them. He may feel

uncertain, not only about the nature of his responsibilities on his job, but also as to how he is going to teach, and perhaps even about what he is going to teach.

There have been some specific studies conducted in other states which indicate, to some extent, the pattern of subjects taught by the science teacher. Although helpful, they have lacked detailed descriptions, and have no direct bearing upon the situation in Illinois. One such study in Colorado shows that only seven per cent of the teachers of physics were teaching physics exclusively; seven per cent of the chemistry teachers instructed only in chemistry; eleven per cent of the biology teachers taught biology alone; while thirty-one per cent of the science teachers instructed in two sciences; and twenty-four per cent of the teachers conducted classes in three or more sciences.[1]

Another study of third class school districts in Pennsylvania elicited the following data: Ten per cent of the physics teachers taught only physics, forty-two per cent were instructing in two subjects, thirty-four per cent held classes in three subjects, and eleven per cent gave courses in four subjects. Thirteen per cent of the chemistry teachers taught only chemistry, forty-eight per cent had classes in two subjects, and eight per cent were giving courses in four subjects. Among the general science teachers twenty-five per cent taught only general science, fifty-six per cent were required to teach two subjects, and seventeen per cent were held responsible for three subjects. Of the biology teachers thirty per cent were teaching biology alone, fifty-three per cent gave course work in two subjects, fourteen per cent were instructing in three subjects, and the remaining three per cent were required to teach four and five subjects.[2]

---

[1]Ada E. Winans and F. C. Jean, "Educational and Professional Status in the Public Schools of Colorado," Science Education, 29-30:133-136, April, May, 1945.

[2]William A. E. Wright, "Subjects Taught by Science Teachers in Third Class School Districts of Pennsylvania," School Science and Mathematics, 45:45-52, January, 1945.

If the situation with respect to subject combinations in Illinois resembles those observed in Colorado and in Pennsylvania, it points up a need for broad training in science and related fields if the beginning teacher is to meet successfully the demands placed upon him.

Even after several years of experience, the teachers of Illinois can not always be sure of full time teaching in a specific field of science. Burnett brought evidence to the support of this fact in a study wherein he sought to determine, among other things, the situation with regard to full time science teaching in Illinois.[3] In this study questionnaires were sent out to the science teachers in the state of Illinois. The responses provide the following data:

1. Out of 357 teachers responding who taught physics, 140 also taught general science, 108 chemistry, 64 biology, and 167 (about 47%) taught subjects other than science.
2. Out of 345 teachers responding who taught chemistry, 140 also taught general science, 117 physics, 88 biology, and 110 (about 31%) taught subjects other than science.
3. Out of 562 responding teachers teaching biology, 223 also taught general science, 85 chemistry, 59 physics, and 98 (about 17%) taught subjects other than science.
4. Out of 612 responding teachers teaching general science, 204 also taught biology, 147 physics, 137 chemistry, and 141 (about 25%) were teaching subjects other than science.

Since the above data came from teachers with varying numbers of years of experience, might the same situation be seen to obtain among beginning science teachers

---

[3] R. Will Burnett, Report to the University of Illinois Committee on the Preparation of Secondary School Teachers of Science, 1950 (unpublished).

who have studied more recently under revised teacher training programs?

Little is known about the problems confronting beginning science teachers in connection with the availability of physical facilities and materials necessary to teaching. It would be reasonable to expect, however, that the laboratory equipment and materials which the teacher will find on his job may be somewhat less adequate, perhaps even meager, in comparison with the facilities of the training school where he studied. How well equipped is he to provide profitable laboratory experiences with such equipment?

Again, a science teacher may lack first-hand acquaintance with certain science class materials. During training, he may have been merely a spectator at the time his instructor was conducting work with particular kinds of instruments or materials. Is training to make the most of available facilities on the job adequate in science teacher training programs? The need for such preparation is strongly implied in the results of a study reported by Sutton in 1944.[4] In this inquiry, the judgments of fifty high school principals and fifty high school science teachers were sought as to why some science teachers fail. Among the reasons given by the principals were these:

(1) Many principals feel teachers do not know how to direct and control laboratory work. There is too great a tendency for the teacher to do all the work.

(2) Poor care of scientific equipment and laboratories. Many teachers do not know how to estimate and order needed science supplies and equipment.

The two reasons listed above gain some support from one among those listed by the teachers:

(1) Inefficiency is caused by not using proper equipment or not using it at the opportune time. The individual who cannot efficiently organize,

---

[4]C. Traver Sutton, "Teacher Failure in Science Teaching," School Science and Mathematics, 44:549-553, 1944.

> maintain, and care for laboratories will find valuable time wasted by teacher and students and materials deteriorating from improper storage or lack of use.[5]

Since most beginning science teachers find their first employment in small schools, it is urgent that they be trained for teaching in such schools. In its report entitled "The Preparation of High School Science Teachers," the Cooperative Committee on Science Teaching pointed out:

> Most new teachers commence their work in small high schools because large schools require teaching experience of candidates for positions. The beginning teacher in a small school nearly always must teach at least three different subjects and often four or five . . . Science teachers are not properly trained for the actual teaching assignments they must accept as beginning teachers.[6]

The above statement acquires strong significance when it is recognized as the considered judgment of a committee which represents the major organizations of the various fields of science throughout the country. The Cooperative Committee on Science Teaching of the A.A.A.S. is composed of representatives from:[7]

National Science Teachers Association
American Association of Physics Teachers
American Astronomical Society
American Chemical Society
American Institute of Physics
American Nature Study Society
American Society of Zoologists
Botanical Society of America
Central Association of Science and Mathematics
Division of Chemical Education of American Chemical Society
Executive Committee of the A.A.A.S. (Amer. Assn. Adv. of Sci.)
Geological Society of America
Mathematical Association of America
National Association of Biology Teachers

---

[5] Ibid., p. 551.

[6] The Cooperative Committee on Science Teaching, "The Preparation of High School Science Teachers," School Science and Mathematics, 42:636-650, 1942.

[7] George G. Mallinson, "A Report to the N.A.R.S.T. on the Activities for 1950-1951 of the Cooperative Committee on the Teaching of Science and Mathematics of the A.A.A.S.," Science Education, 35:189-190, October, 1951.

National Association for Research in Science Teaching
National Council of Teachers of Mathematics
Education section of the A.A.A.S.
The U. S. Office of Education

All of these studies and reports imply certain desirable training programs, but none of them attempt to detail the desirable or necessary competencies for which training may be provided. There is positive value to be gained from information about those competencies which spell success for the beginning teacher on his new job. His success, or his lack of it, on this first assignment, will affect his future in terms of promotions in salary and to positions of greater responsibility. But even more important, the youth of those schools served by beginning teachers should not be penalized by poor teaching.

The competencies desirable in a beginning science teacher have several major facets. One problem the beginning science teacher is almost sure to face is that of individual differences in learning capacities among pupils in his classes. In the public schools he is likely to encounter a much wider range of intelligence--from the slowest learner to the most gifted--than he observed among his fellow students in the school or college where he was trained. What preparation would aid him in meeting this problem? Common practice in the public schools has been to gear instruction to the learning abilities of students of <u>average</u> intelligence, thus neglecting both the slow and the gifted learners. Of these two groups, however, the slow learners probably were less neglected, because teachers have often given them individual help, whereas it was not clearly perceived that an exceptionally bright child might need help and guidance. In the opinion of W. D. Reeve,

> . . . the most retarded pupil in the American public schools is the pupil with a gifted mind . . . Future teachers must have a preparation which will provide the subject-matter background which is the basis for teaching.[8]

[8] W. D. Reeve, "Subject Matter Specialization in the Training of Teachers," <u>Teachers College Journal</u>, 17:29-30, November, 1945, p. 30.

It would seem, indeed, that a teacher needs both adequate depth of preparation in his science fields, and a certain skill in applying pertinent principles of psychology to his instruction, if he is to offer the guidance and intellectual challenge so necessary to the progress of the brilliant pupil.

Does the novice teacher recognize this problem of working with students of various abilities? Does he know what procedures and learning experiences are necessary to motivate and challenge the gifted pupils?

A second problem of the beginning teacher is that of adjusting his instruction to the needs of his students and the community he serves. Little or no specific data are available about the problems the beginning science teacher faces in focusing his subject matter and professional training to the school and community in which he teaches. Certainly, these teachers, with daily problems fresh in their minds, could provide a valuable source of information to those preparing to follow them into the field.

A third problem concerns the handling of controversial issues in the classroom. A study by Burnett, which had nationwide responses, dealt in part with the problem of handling controversial issues arising out of classroom discussion.[9] It was found that teachers often avoid controversial matters with which young people have to deal because (1) they fear the disapproval of parents; (2) of the immaturity of students; and (3) they (the teachers themselves) have insufficient knowledge of the subjects at issue to handle such discussions adequately. Yet many important problems requiring knowledge of science are controversial in nature. Do Illinois science teachers have adequate preparation to handle such issues competently?

---

[9] R. Will Burnett, "Opinions of Science Teachers and Their Implications for Teacher Education," Teachers College Record, 42:709-719, 1941.

A fourth problem is that of course planning. How frequently are beginning science teachers called upon to decide for themselves the pattern of instruction they will follow? With a given set of objectives in mind, how well are the beginning science teachers able to plan instruction in terms of (1) meeting needs and interests of students; (2) fitting the instruction to the school's program of general education; and (3) giving real help to those students who plan to go to college?

The present study attempts to secure answers to these questions from beginning science teachers and from the administrators who employ them. The judgment of administrators is of particular interest. The teacher of science faces competition in the "market for jobs." Administrators must choose from among applicants those best qualified, in their judgment, to fill the positions open. Thus, to the extent that the judgments of school administrators determine what qualifications should be expected in candidates for staff openings, information concerning the nature and substance of these judgments would be both pertinent and valuable. What do these employers demand as a minimum, and what do they consider the optimum to be in subject-matter competence, in professional understandings and skills, and in the overall educational background of the prospective science teacher? How much study time would they recommend to be spent in a full teacher-training program? In the employers' opinion, how much time should be spent on particular subjects or fields of study during training? Where would an administrator recommend that the strongest emphasis be placed--where the least? What kind of student-teaching experiences would best fit would-be staff members for handling the classroom practices deemed appropriate by administrators for their particular schools? These judgments are not known. The present study seeks to determine the viewpoints of administrators on these questions. For whether these judgments are sound or not, they represent the views of those in a position to

hire or reject the products of the training institutions.

One of the most debated issues in teacher-training program planning is that of the allotment of time. The present general trend in time-planning for the science teacher training program would seem to be one of best compromise. On the one hand, the teacher-in-training is faced with an urgent need to "get out on his own," to earn his own living, as early as possible. Few would be attracted to the profession of high school science teaching under present salaries if it meant spending a period longer than four or, at the most five years of preparation beyond the high school diploma. On the other hand, there is often such a wealth of desirable course offerings, and such a chorus of diverse opinions as to what studies are indispensable to his preparation, that the future teacher is faced with a real dilemma in planning for the richest program possible under severe time limitations. Since high school administrators could be expected to form judgments largely based upon what they see taking place in the classrooms of their schools, their appraisal of the relative disposition of training time should prove of value both to student-teachers and to the staff members of the institution responsible for devising and guiding the student's program.

The present state of flux within our society must logically have some effect upon our schools. The growing complexity and diversity within our social structure is reflected in our school populations. That constant developments in science and technology create an equally constant outgrowth of new social problems, has long been recognized by students of society. On such premises it might then be said that, insofar as schools are an integral part of the society they serve, to that degree are they affected by the problems currently besetting that society. The role of the teacher in such a situation can be seen to be pivotal. For, upon the teacher falls the task of helping youth to study these problems, and of guiding them toward their resolution.

The foregoing description of the role of a teacher in a changing society would necessarily be based on the assumption that the society has come to expect a great deal more of its schools and their teachers than it has in the past. Ample evidence can be found in present day public education to support this assumption. In the realm of educational policy and planning, there has been a distinct shift in emphasis from instruction in specialized, unrelated subjects, toward more general and more broadly conceived curriculums. There has been increasing stress upon integration of instruction. An example of this is the study of atomic energy and its control and development. This study involves aspects of the fields of nuclear physics and the social sciences. Conservation, health, and consumer education are other examples of broad social problems involving science learnings.

Other evidence of the increasing demands of society upon the science teacher and the extension of services expected of the schools in general is found in the development of the home-room system and of vocational guidance and counseling. Many science teachers are called upon to deal with young people on a basis quite distinct from that set down by the teaching-learning situation in the classroom.

Certainly, then, one way to meet the challenge of such new demands upon the teaching profession would be to discover and to describe in concrete terms those things which a teacher ought to know and be competent to do in the discharge of his responsibilities as they are seen through an analysis of teaching jobs now being performed.

## C. DEFINITION OF TERMS

Beginning science teachers, for the purposes of this study, are those practicing teachers who have taught for three years or less. These teachers have presumably had little or no opportunity to rectify their perceived deficiencies

through further study in teacher-training institutions, or by in-service training. It is assumed, therefore, that the problems which they have encountered, and the relation of these problems to the character of their training will be relatively fresh in their minds.

School administrators, as discussed in this study, are those individuals responsible for the employment of science teachers in the high schools of the various school systems, public and private (including parochial), throughout the State of Illinois.

Competencies, in this study, refer to those abilities, capacities, skills, and understandings which can be learned or developed through specific training for the performance of the work of a high school science teacher. They do not include loosely termed concepts of "talents" or "aptitudes" for which neither training nor reliable methods of measurement have been devised.

## D. BASIC ASSUMPTIONS UNDERLYING THE STUDY

1. It is assumed that teacher training institutions are interested in data coming from members of the teaching profession out in the field which might enable them to provide better training programs for prospective teachers. Those individuals in the field who might provide data for this study are assumed to be both the teachers on-the-job, and the school administrators who employ these teachers.

2. It is assumed that the problems encountered by beginning science teachers on their jobs, and their ability to solve them, are often seen by these teachers to have a direct relation to the kind of preparation they have had for their work. These problems and difficulties, as reported by science teachers, would be of interest to teacher training institutions in their efforts to improve their programs.

3. It is further assumed that, by virtue of their positions as employing

officers, high school administrators will have certain conceptions as to the kind of training necessary for the science teacher in carrying out his part in a total school program. As a result of first-hand observation, administrators will have an idea of the relation between inadequate training and the consequent difficulties this presents both for the school and the individual science teacher. Thus, teacher training institutions would be interested in the insights and opinions of high school administrators regarding the type of preparation which should be incorporated into the training program for science teachers.

# CHAPTER II

## INSTRUMENTS AND TECHNIQUES

### A. POPULATIONS USED

In its search for judgments regarding the competencies which are either required or recommended in beginning high school science teachers, this inquiry made use of: (1) beginning science teachers, and (2) the school administrators who employ science teachers.

In the first group of subjects were Illinois science teachers then teaching their first, second, or third year in high schools. These individuals were located through the files of the State Superintendent of Public Instruction in Springfield, Illinois. These files furnished the name, location, field of teaching, and the year(s) of experience for each science teacher selected. All files for each county in the state were carefully examined in the spring of 1950. Since the total number of teachers falling into the category of those sought for study was 317, it was decided to make use of the entire group. This group was canvassed late in the spring of 1950.

The names and addresses of the administrators were secured from the University of Illinois Mailing Service. The names of all principals and superintendents of high schools, and junior high schools, public, parochial, and private, numbered 1281. Of this list a sampling was made whereby every third name was selected for use in the study, making a total of 427. This group was canvassed in the spring of 1951.

### B. CONSTRUCTION AND ADMINISTRATION OF THE INVENTORIES

The Administrators' Inventory. The sampling of the two populations in this study required the construction of two questionnaires. The instrument developed

for securing the judgment of administrators was entitled "What Do You Want in the Training of Science Teachers for Illinois High Schools?"[1] Materials incorporated into this questionnaire were derived from three sources: data from studies in the field of science teaching; stated opinions of experts in the field of science teaching; and, finally, the personal experiences, as a high school science teacher, of the present writer.

The instrument was divided into seven sections. Of these, the first six were respectively designed to secure judgments concerning: (1) classroom techniques; (2) competencies required or considered desirable with respect to professional responsibilities; (3) applications of science to general education: (4) understanding boys and girls; (5) other aspects of professional training; and (6) training in the subject matter fields of science. The seventh section invited comments, criticisms, and additions to the entire instrument. In addition to the entire seventh section, the same opportunity for comments, criticisms, and suggestions was afforded at the end of each of the first six sections of the inventory. The introductory part of the instrument included a statement of purpose, a request for help, and complete directions for checking.

Copies of an original draft of the instrument were mimeographed and a trial sampling brought replies from fifteen respondents. The results of the trial run indicated that the instrument was understandable and ready for use. It was then printed, under the sponsorship of the Follow-Up Division of the University Council on Teacher Education and sent out by the University of Illinois Mailing Service.

The Teachers' Inventory. The construction of this instrument was based upon materials developed from sources similar to those used for the administrators'

---

[1]See Appendix for copies of both inventories and all letters and forms sent out in connection with them.

inventory. It was entitled "Problems and Questions Concerning Teachers New in the Field of High School Science Teaching." After a prefatory statement of the purpose of the questionnaire, and a request to the science teacher for his help, appeared the following statement: "In no case do we wish to gain your identity, so please do not sign your name." It was felt that this would aid in the securing of frank and direct answers. This instrument requested the following information: the size of the school in which the responding teacher was employed; his training and experience; the nature of his duties on the job; and the science course or courses he was currently teaching. The teacher was also asked to state his opinion about his subject matter preparation, the adequacy of his training for competent participation in the life of a democratic society, and to give certain judgments concerning the school in which he was teaching. He was finally requested to indicate the degree of success he felt that he was experiencing as a teacher.

A tentative form of the questionnaire was sent out on a trial basis, and responses were obtained from sixteen teachers. These teachers were not selected from the original list, but were teachers with more than three years of experience. These teachers, as requested, supplied evaluations of various parts of the instrument, suggestions for clarifying the questions, and improvements in ways of checking answers. The inventory was then printed and sent out to the science teachers on the list under the sponsorship of the Follow-Up Division of the University Council on Teacher Education.

Each teacher and administrator to whom the inventory was sent received an accompanying letter which explained the purpose of the study and requested the individual's cooperation in filling out and returning the form. The letter was mimeographed on College of Education stationery and signed by Willard B. Spalding, Dean of the College of Education, and Executive Officer of the Council on Teacher

Education of the University of Illinois. Two follow-up letters were sent to the science teachers and one was sent to the school administrators. These follow-up letters were sent to bring in additional replies. Copies of the inventories, their accompanying letters, and the follow-up letters are included in the appendix.

## C. RESPONSE TO THE INVENTORIES

Responses from the Administrators. Of the 427 administrators whose names had been selected by the sampling techniques described earlier, 295 responded by filling out and returning the instrument. Two inventories were returned with responses so incomplete as to be unusable in the study. Table I shows a breakdown of the total 295 returned inventories (including the two unusable responses) with respect to size and type of school.

Table I

Responses from Administrators of Schools of Various Kind and Size to the Inventory "What Do You Want in the Training of a Science Teacher for Illinois High Schools?"

Total Number of Inventories Sent . . . . . 427

Number of Inventories Received from Administrators of Schools of Varying Size and Kind

| Type of School | Number of Responses | Per Cent of Total Responses |
|---|---|---|
| Student Population of: | | |
| Less than 100 | 41 | 13.9 |
| 100 - 249 | 100 | 33.9 |
| 250 - 499 | 60 | 20.4 |
| 500 - 999 | 30 | 10.2 |
| 1000 or more | 28 | 9.5 |
| Private and Parochial | 33 | 11.2 |
| Unclassified | 3 | .1 |

Total Number of Inventories Returned . . . . . 295

Per Cent of Response . . . . . 69

Returns from the administrators were tabulated in groups of fifty. An average for all responses was computed for the first 150 inventories. The average for the first 150 inventories was then compared with the responses on the fourth fifty inventories and on the fifth fifty inventories. Almost no change in the pattern of responses was noted after the average of the first 150 inventories had been tabulated. This would appear to indicate that the size of the sample was sufficient to secure a pattern of responses representative of the larger group of administrators from which the sample was drawn.

Responses from the Science Teachers. The instrument for the beginning science teachers was sent out to them in May, 1950, at the end of the school year. It was sent at this time in order to account for as nearly a full year of teaching experience as possible for those teaching on their first assignment. The selection of this period, however, was somewhat inopportune for the teachers. The questionnaire, arriving just at the end of the school year, came to the teachers at a time when most of them were very busy. Of the 317 inventories sent out, 127 were returned. Eight responses were found to be not usable in this study. Table II indicates the distribution of these returns with respect to the size of the schools served by these teachers.

Table II

Responses from Beginning Science Teachers in Schools of Various Size to the Inventory, "Problems and Questions Concerning Teachers New in the Field of High School Science Teaching"

Total Number of Inventories Sent . . . . . 317

Number of Inventories Sent and Received from Teachers in Schools of Various Size

| Schools with Student Populations of: | Number Sent | Number Received | Per Cent of Total Sent | Per Cent of Total Received |
|---|---|---|---|---|
| Less than 100 | 97 | 32 | 30.6 | 25.1 |
| 100 - 249 | 145 | 65 | 45.7 | 51.1 |
| 250 - 999 | 64 | 23 | 20.1 | 18.1 |
| Over 1000 | 11 | 7 | 3.4 | 5.5 |

Total Number of Inventories Returned . . . . . 127

Per Cent of Response . . . . . 40

## D. LIMITATIONS OF THE STUDY

There are certain limitations inherent in the method of collecting data for a study of this type by means of questionnaires. A consideration, not only of these limitations, but also of some of the means used to overcome them, will aid in the interpretation of the data presented in the ensuing discussion.

One difficulty lies in the phrasing of questions to prevent the bias of the one asking the questions from suggesting answers to the respondents. Another problem arises out of the ever-present uncertainty that the respondents to the inventory may or may not represent a truly random sample of the population under study. Again, the individuals queried probably vary widely in both educational and socio-economic backgrounds. This creates additional uncertainty about the wide variety of meanings that individuals of differing backgrounds might attribute to the same question. Another danger lies in the apparent opposite direction--that the group questioned may be too select, too homogeneous. This would diminish the validity of the study with respect to its being representative of the population being analyzed.

A further limitation is that responses to questions--in such a study as the present one--represent judgments and opinions. Such testimony, despite the careful consideration and the emphasis upon "matters of fact" which it may have been given, is not always reliable. Unconscious bias may affect a person's notion of what is, to him, a fact. In other cases respondents may make hasty or ill-considered answers.

In recognition of such limitations as those described above, measures were taken to overcome them or to minimize their effects upon the outcomes of the present study. The first drafts of the questionnaires to be used were reviewed repeatedly and thoroughly by professional educators. Trial runs were made. These led to the location and removal insofar as possible of such defects in the

questionnaires as bias, vague wording, or inadequate directions for checking responses. The administration, in final forms, of the questionnaires to a fairly large population, and the resultant satisfactory number of returns, minimized the possibility of failure in securing a random sampling of the populations. This would, at the same time, eliminate to a considerable extent the danger of getting replies from only a select group of administrators or teachers. Another means of increasing the reliability of the response consisted in the application of the Chi-square test of significance to the comparison of responses of sub-groups in the study. A five per cent level of significance was chosen. This means that, if there were five or fewer than five chances in a hundred that chance alone could produce a difference in response as large as the observed difference, then the observed difference would be considered statistically significant.

The nature of a problem dictates the method which will be the most feasible for reaching its solution. In such a study as this, where it was necessary to contact many administrators and teachers from over a wide area, in as short a time as possible, and at a minimum of expense, the questionnaires appeared to offer the greatest possibility for fruitful inquiry.

Another factor favoring the reliability of the method chosen is that the respondents, as practicing members of the teaching profession, and by virtue of familiarity with everyday educational problems, could be expected to understand and recognize the implications of the questions.

To offset the possible inconclusiveness of the results of this study with respect to the questions at issue, it may be asserted that such a study at least brings these questions into clearer focus. Even in science, final answers are rarely found, and many accepted answers are revised on the basis of new findings. This lack of finality does not, and should not, prevent the use of all presently accepted answers whenever and wherever they are applicable.

On the basis of the foregoing considerations, it seems reasonable to assume that despite the limitations implicit in this type of study, the results which will be reported have reasonable validity.

# CHAPTER III

## WHAT ADMINISTRATORS WANT IN THE TRAINING OF SCIENCE TEACHERS FOR ILLINOIS HIGH SCHOOLS

The administrators' inventory provided opportunity for the respondents to indicate whether each listed competency should be considered as: (1) a minimum essential in the training program; (2) important and to be included in the training program if possible; or (3) not important in the training program. In addition, space was provided for the respondent to write in additional competencies which he then could rank in importance as indicated above.

As previously noted, the competencies listed were placed under one or the other of six headings in the questionnaire: (1) Classroom Techniques, (2) Professional Responsibilities, (3) Application of Science to General Education, (4) Understanding Boys and Girls, (5) Other Aspects of Professional Training, (6) Training in the Subject Matter of Science.

The last category (Training in the Subject Matter of Science) employed a different technique for securing responses than indicated above. Five patterns of possible subject matter preparation were listed and the respondents were asked to rank these patterns in order of their preference. In addition, the respondents were asked to rank three patterns of student teaching according to their preference.

This chapter is concerned with the responses of the administrators of the State on these items. The data on these responses are given in Tables II, III, IV, V, VI, VII, and VIII, which present the responses of the administrators in percentages. The items in each table appear in the order of administrative judgment of essentiality as shown by the returns.

## A. TRAINING IN CLASSROOM TECHNIQUES

This section of the questionnaire sought to determine the administrators' viewpoint on the question of classroom techniques and the place for them in the science teacher training program. In the fields of science the need for effective and versatile teaching is important for at least two reasons. First, the tremendous range and increasing scope of current developments in the sciences make it necessary to acquaint students with as broad a range of scientific knowledge as possible without, however, sacrifice of learning in the fundamental disciplines and concepts underlying all of science. This would require of the teacher both organizational skill and sound judgment. Secondly, as science and technology become more and more central to the interests of our society, not only is it likely that more young people will choose careers in science, but it is also desirable that all people have a working fund of scientific knowledge directly applicable to daily living. This would require instruction to meet a broad range of interests and needs on the part of the students.

A list of nine elements in classroom technique was submitted for the administrators' judgment. Out of this list (see Table III) more than half of the administrators responding judged the following competencies to be minimum essentials for sound science teaching and thus necessary in the training program for science teachers:

(1) Competence in classroom management and organization.

(2) Ability to plan units of work in a particular teaching field.

(3) Ability to plan and perform science class demonstrations.

(4) Ability to employ a wide range of teaching techniques.

Number (1) above was, however, the only technique considered by all the administrators as so important that it should not be left out of the training program.

Table III

Judgments of High School Administrators Regarding the Importance of Various Competencies in the Area of Classroom Techniques in the Science Teacher Training Program

| Competencies in Classroom Techniques | Per Cent of Administrators Who Think Each Competency: | | |
|---|---|---|---|
| | Is a Minimum Essential | Is Important Include if Possible | May Be Left Out |
| 1. Classroom management and organization | 88 | 12 | 0 |
| 2. Planning units of work in a particular teaching field | 80 | 18 | 1 |
| 3. Ability to plan and perform science class demonstrations | 72 | 27 | 1 |
| 4. A wide range of teaching techniques | 55 | 40 | 5 |
| 5. Aiding students to select and work out projects in connection with the science work | 44 | 50 | 6 |
| 6. Directing students in how to use the library and resources of the school and community | 43 | 52 | 4 |
| 7. Constructing various kinds of tests for measuring progress of students | 42 | 48 | 10 |
| 8. Planning and conducting field trips | 36 | 56 | 8 |
| 9. Selecting audio and visual aids for his science classes and operating the necessary machines to use them | 36 | 58 | 6 |

Less than half of the respondents chose the remaining five competencies as minimum essentials in science teacher training. Nevertheless, it is worth noting that in the case of every one of the nine classroom techniques listed in the questionnaire, at least ninety per cent of the administrators judged the competencies worthy of inclusion in the training program if possible even if not as minimum essentials. No write-ins were offered by the respondents for this section of the questionnaire.

## B. TRAINING FOR PROFESSIONAL RESPONSIBILITIES

The professional responsibilities of the science teacher embrace his activities as a professional person. They have to do not only with the way he discharges his daily tasks of teaching and handling science materials, but also with the degree to which he keeps himself abreast of current trends and developments in his science field. It is clear that the professionally alert young science teacher can offer much to the school in which he works, both in the classroom and as a staff member.

Table IV indicates the opinions of the administrators of a list of six elements of competence in the area of professional responsibilities. The responses revealed that from one-half to two-thirds of the administrators considered it necessary for prospective science teachers to be equipped with the following three competencies:

(1) Knowledge of the proper care and storage of science materials and equipment.

(2) Ability to select and specify accurately the science materials necessary to the teaching of a particular course.

(3) Ability to keep in touch with and to locate information on recent developments in science.

Table IV

Judgments of High School Administrators Regarding the Importance of Various Competencies in the Area of Professional Responsibilities in the Science Teacher Training Program*

| Competencies in Professional Responsibilities | Per Cent of Administrators Who Think Each Competency: | | |
|---|---|---|---|
| | Is a Minimum Essential | Is Important Include if Possible | May Be Left Out |
| 1. Proper care and storage of scientific materials and equipment | 68 | 30 | 2 |
| 2. Ability to select and specify accurately the science materials and equipment necessary to the teaching of a particular course | 63 | 34 | 3 |
| 3. Ability to keep in touch with, and to locate information on, the most recent developments in science | 52 | 40 | 4 |
| 4. Skill in repairing equipment and constructing simple apparatus for classroom use | 36 | 58 | 6 |
| 5. Knowledge of the value of various organizations of his profession and of the benefits to be derived from affiliation with them | 19 | 58 | 17 |
| 6. Skill in using and explaining some of the more complex apparatus found in the science equipment | 19 | 51 | 30 |

*See Appendix, Administrator's Inventory Section II for original wording of items.

No more than four per cent of the administrators thought that any one of these competencies should be left out of the training program.

The remaining three competencies listed in this section of the questionnaire were:

(4) Skill in repairing equipment and constructing simple apparatus for classroom use.

(5) Knowledge of the value of various organizations of the profession and of the benefits to be derived from affiliation with them.

(6) Skill in using and explaining some of the more complex apparatus found in the science equipment.

Although they were selected as minimum essentials in the training program by less than half of the respondents, well over half of the administrators thought these competencies of sufficient importance to be included in the program if possible. If the responses of administrators asserting these last three competencies to be minimum essentials are combined with the responses of those who ask that they be included if possible, we find that seventy per cent or more of the respondents believed that each of the three competencies should be developed in the training program. And we find, further, that ninety per cent of the administrators favored development of the first four out of the six competencies listed on Table IV in this area. No additional competencies were suggested for this section of the questionnaire by the respondents.

### C. TRAINING IN THE APPLICATION OF SCIENCE TO GENERAL EDUCATION

Table V lists nine skills or understandings which a teacher might need in applying science to general education. These nine constituted the items for this section of the administrators' questionnaire. Two-thirds of these competencies--or six out of the nine--were rated by over one-half of the administrators as minimum essentials to be developed by the training programs for science teachers.

Table V

Judgments of High School Administrators Regarding the Importance of Various Competencies in the Area of Application of Science to General Education in the Science Teacher Training Program

| Competencies in the Application of Science to General Education | Per Cent of Administrators Who Think Each Competency: | | |
|---|---|---|---|
| | Is a Minimum Essential | Is Important Include if Possible | May Be Left Out |
| 1. Planning the science instruction to meet the real life needs of the pupils in your school | 83 | 16 | 1 |
| 2. Teaching the contribution and effective use of his branch of science to personal and public health | 73 | 26 | 1 |
| 3. Application of science to the conservation of natural resources | 72 | 27 | 1 |
| 4. Interpreting the effects of science and technological development upon present day society | 72 | 26 | 2 |
| 5. Understanding the nature of science as a method of critical inquiry | 54 | 37 | 9 |
| 6. Using the facilities of the community as a resource for teaching science | 51 | 47 | 2 |
| 7. Helping students to apply scientific methods and facts to the solution of some consumer problems | 42 | 51 | 7 |
| 8. Helping students to increase their enjoyment of leisure activities through science understandings and skills | 38 | 53 | 9 |
| 9. Helping youth to apply scientific methods and facts to problems of marriage and family relations | 35 | 45 | 20 |

These six, in order of preference, are competencies:

(1) In planning science instruction to meet the real life needs of the pupils in the school.

(2) In teaching the contribution of his branch of science to personal and public health.

(3) In applying science to the conservation of natural resources.

(4) In interpreting the effects of science and technological development upon present day society.

(5) Resulting from an understanding of the nature of science as a method of critical inquiry.

(6) In using the facilities of the community as a resource for teaching science.

Somewhat fewer than fifty per cent of the administrators valued the last three competencies listed in Table V as minimum essentials. But that these competencies were held to be of some importance becomes apparent upon study of the total responses to these items. Eighty per cent or more of the administrators felt that the last of these competencies ought to be developed either as minimum essentials or to be included if possible in the science teacher training program. These competencies, ranked according to preference, are:

(7) Helping students to apply scientific methods and facts to the solution of some consumer problems.

(8) Helping students to increase their enjoyment of leisure activities through science understandings and skills.

(9) Helping youth to apply scientific methods and facts to problems of marriage and family relations.

It should be noted, however, that one out of five administrators felt that training in the last competence listed (problems of marriage and family relations)

could be left out of the program training science teachers for their work.

## D. TRAINING FOR UNDERSTANDING BOYS AND GIRLS

A list of nine competencies, presumably of some importance to teachers for the better understanding of boys and girls, was submitted to the judgment of the administrators. These are ranked in Table VI according to the order of essentiality as judged by the respondents. The responses indicate that administrators attach a great deal of importance to a teacher's capability in this area. Only two out of a hundred administrators felt that any of the first five listed were sufficiently unimportant that they need not be provided for in the training of science teachers. The five competencies most frequently judged indispensable are:

(1) Planning and providing for individual differences of students in the science classroom.

(2) Knowledge of the physical and mental development of boys and girls of adolescent age.

(3) Knowing the interests and needs of boys and girls at different grade levels.

(4) Knowing the physical, mental, and social characteristics that affect the progress of all learners.

(5) Knowing how to develop pupils' study techniques in science.

Two additional competencies (Numbers 6 and 7 in Table VI) received high acceptance as important in training programs. Only six per cent of the respondents felt that Item 6 (Knowledge of the techniques for counseling boys and girls of high school age) should be ignored. Eleven per cent felt that Number 7 (Training in matters concerning sex adjustments of adolescents, physiology of sex, and emotional orientation in matters of sex) might be excluded from science teacher training.

Table VI

Judgments of High School Administrators Regarding the Importance of Various Competencies in the Area of Understanding Boys and Girls in the Science Teacher Training Program

| Competencies in Understanding Boys and Girls | Per Cent of Administrators Who Think Each Competency: | | |
|---|---|---|---|
| | Is a Minimum Essential | Is Important Include if Possible | May Be Left Out |
| 1. Planning and providing for individual differences of students in the science classroom | 81 | 19 | 0 |
| 2. Knowledge of the physical and mental development of boys and girls of adolescent age | 81 | 19 | 0 |
| 3. Knowing the interests and needs of boys and girls at different grade levels | 70 | 29 | 1 |
| 4. Knowing the physical, mental, and social characteristics that affect the progress of all learners | 70 | 28 | 2 |
| 5. Knowing how to develop pupils' study techniques in science | 63 | 32 | 2 |
| 6. Knowledge of the techniques for counseling boys and girls of high school age | 40 | 50 | 6 |
| 7. Training in matters concerning sex adjustments of adolescents, physiology of sex, and emotional orientation in matters of sex | 39 | 50 | 11 |
| 8. Training in sociometric techniques as tools to increase understanding of peer relationships existing in the classroom | 19 | 52 | 28 |
| 9. Training in psychometric techniques useful in making case studies of certain students | 10 | 50 | 40 |

Less than one-fifth of the administrators considered the final two competencies (Numbers 8 and 9, Table VI) to be essential, and a high percentage--forty per cent in the case of Number 9--favored omission of these from science teacher programs.

It is clear that the responding administrators rate an understanding of boys and girls as extremely important in the qualifications of a science teacher. This is more than borne out by the emphatic support accorded by the administrators to the inclusion as minimum essentials in the science teacher training curriculum the development of the first five competencies listed in this area.

## E. OTHER ASPECTS OF PROFESSIONAL TRAINING

In this section of the inventory the administrators were asked to judge the relative importance of twelve aspects of professional training other than those already covered (see Table VII). Eight of these competencies were suggested as minimum essentials in the science teacher training program by fifty per cent or more of the responding administrators. These eight competencies are:

(1) Skills in the communication of ideas.

(2) Development of a personal philosophy of education and a consistent view of the function of science teaching in the fulfillment of that philosophy.

(3) Knowledge of the ethics of the teaching profession.

(4) Ability to work effectively with others in solving problems of the school.

(5) Development of a coherent world outlook, enabling the teacher to help students adjust to conflicts resulting from the impact of a scientific interpretation of the world upon their concepts of time, space, evolution, the earth's position in the universe, man's position among living things, etc.

(6) Knowledge of the responsibilities involved in participation in the social and civic life of the community served by the teacher.

Table VII

Judgments of High School Administrators Regarding the Importance of Various Competencies in Other Aspects of Professional Training in the Science Teacher Training Program

| Competencies in Other Aspects of Professional Training* | Per Cent of Administrators Who Think Each Competency: | | |
|---|---|---|---|
| | Is a Minimum Essential | Is Important Include if Possible | May Be Left Out |
| 1. Skills in the communication of ideas (reading, writing, spelling) | 80 | 18 | 2 |
| 2. Development of a personal philosophy of education and a consistent view of the function of science teaching in the fulfillment of that philosophy | 73 | 26 | 1 |
| 3. Knowledge of the ethics of the teaching profession | 70 | 27 | 2 |
| 4. Ability to work effectively with others in solving problems of the school | 64 | 34 | 2 |
| 5. Development of a coherent world outlook, enabling the teacher to help students adjust to conflicts resulting from the impact of a scientific interpretation of the world upon their concepts of time, space, evolution, the earth's position in the universe, man's position among living things, etc. | 63 | 35 | 1 |
| 6. Knowledge of the responsibilities involved in participation in the social and civic life of the community served by the teacher | 57 | 40 | 3 |
| 7. Problems of the high school curriculum and the place of science in it | 56 | 40 | 4 |
| 8. Ability to attack and work out either personal problems or those of the school | 50 | 42 | 8 |
| 9. Ability to locate and interpret research in the fields of education and science teaching | 47 | 50 | 3 |
| 10. Ability to interpret various diagnostic instruments that the school may employ (I.Q. tests, aptitude tests, interest tests, etc.) | 44 | 50 | 6 |
| 11. Ability to interpret the educational statistics used in educational literature | 23 | 60 | 17 |
| 12. Knowledge of the basic school laws of the state | 19 | 56 | 25 |

*See Appendix for exact wording of these statements.

(7) Problems of the high school curriculum and the place of science in it.

(8) Ability to attack and work out either personal problems or those of the school.

In no case among the eight did more than eight per cent of the respondents suggest omission from the training program. Although the competencies numbered 9 and 10 in Table VII received a slightly less favorable total vote for inclusion as minimum essentials, only three per cent of the administrators considered Item 9 to be entirely dispensable in the teacher training program. Six per cent felt that Item 10 was not essential. These two competencies are:

(9) Ability to locate and interpret research in the fields of education and science teaching.

(10) Ability to interpret various diagnostic instruments that the school may employ (I.Q. tests, aptitude tests, interest tests, etc.)

The majority of the responding administrators seemed reluctant to vote the last two professional skills listed in Table VII entirely out of the science teacher training curriculum, although a relatively small percentage (twenty-three per cent on Item 11 and nineteen per cent on Item 12) considered them to be essential. These two were:

(11) Ability to interpret the educational statistics used in educational literature.

(12) Knowledge of the basic school laws of the state.

The administrators indicated in their returns for this area that a great variety of skills, other than the eight they ranked as most important, are of positive value for the science teacher. It would appear that they consider the responsibilities of the individual teacher--whatever his subject field--to extend beyond the classroom. Implicit in this broader range of obligations was the conception of the science teacher working in cooperation with other teachers toward

solution of problems common to the whole school. The effectiveness of a science teacher in working with others was held to be related both to the quality of his skills and understandings in the communication of ideas, and to his recognition of and adherence to the ethical standards of the teaching profession. Apparently the administrators feel that the development of such skills of effective cooperation should be a responsibility of the teacher training institutions and should not be left to chance.

The administrators also generally considered the science teacher as playing a necessary role in the planning and execution of the high school program. For the adequate fulfillment of this role three elements were held significant. First, the teacher should have developed a mature philosophy of the role of education and of science teaching within that role. Secondly, he should be able to implement that philosophy through an understanding of the place of science teaching in the high school curriculum. And finally, his training in the fields of science should be sufficiently thorough that he can transmit to boys and girls the learnings in science that are essential to their education. Administrators apparently agree that ability to interpret research in education and science teaching is a valuable skill. Such a skill would enable the teacher not only to keep abreast of developments in the field, but also to apply correctly to practice the new ideas coming out of current research.

## F. TRAINING IN THE SUBJECT MATTER OF SCIENCE

In this section of the inventory five patterns of subject matter training for science teachers were submitted to the appraisal of the high school administrators. They were asked to rank the five patterns in order of preference by marking their first choice as number 1, second, 2, and so on down to the least preferred pattern of training, to be ranked as 5.

## Table VIII

### Preferences of High School Administrators for Various Patterns of Science Subject Matter Training in the Science Teacher Training Program

| Patterns of Science Subject Matter Training | Per Cent of Administrators Who Rank Each Pattern as a: | | | | |
|---|---|---|---|---|---|
| | First Choice | Second Choice | Third Choice | Fourth Choice | Fifth Choice |
| 1. Intensive training in one field of science subject matter such as physics, chemistry, etc., and little or no training in biology | 1 | 1 | 4 | 9 | 83 |
| 2. Sufficient training in several science subject fields such as physics, chemistry, biology, earth science, etc., so that the teacher can give instruction in more than one of the sciences | 36 | 30 | 18 | 13 | 2 |
| 3. Training spread over several science subject matter fields as in 2 and, in addition, intensive training in one field of science as in 1 | 39 | 26 | 24 | 10 | 1 |
| 4. Training in survey courses of science (physical and biological) followed by specialization in a single field of science such as physics, chemistry, etc. | 11 | 18 | 31 | 33 | 5 |
| 5. Training divided equally, or nearly so, in two broad fields of science such as physical science and biological science | 13 | 18 | 26 | 33 | 8 |

Table VIII (Continued)

| Patterns of Science Subject Matter Training | Weights Assigned to the Administrators' Responses | | | | | | |
|---|---|---|---|---|---|---|---|
| | First Choice | Second Choice | Third Choice | Fourth Choice | Fifth Choice | Total Weighting | Rank on the Basis of Weighting |
| 1. Intensive training in one field of science subject matter such as physics, chemistry, etc., and little or no training in biology | 5 | 4 | 12 | 18 | 83 | 122 | 5 |
| 2. Sufficient training in several science subject fields such as physics, chemistry, biology, earth science, etc., so that the teacher can give instruction in more than one of the sciences | 180 | 120 | 57 | 26 | 2 | 385 | 2 |
| 3. Training spread over several science subject matter fields as in 2 and, in addition, intensive training in one field of science as in 1 | 195 | 104 | 72 | 20 | 1 | 392 | 1 |
| 4. Training in survey courses of science (physical and biological) followed by specialization in a single field of science such as physics, chemistry, etc. | 55 | 72 | 63 | 66 | 5 | 261 | 4 |
| 5. Training divided equally, or nearly so, in two broad fields of science such as physical science and biological science | 65 | 72 | 52 | 66 | 8 | 263 | 3 |

The responses, tabulated in Table VIII, have been indicated in two ways: by percentages and by weights. The weighting of first choices as five times that of fifth choices serves to point up clearly the collective judgment of the administrators. Choices listed as Numbers 1 and 2 in Table VIII stand rather close together at the top of the list with weights of 392 and 385 respectively.

Training pattern Number 3, that most frequently accorded first choice, is designed to provide training spread over several science subject fields such as physics, chemistry, biology, earth sciences, etc., and in addition, intensive training in one field of science such as physics, chemistry, or biology.[1]

The second type of subject matter training which administrators would most prefer for science teachers would offer sufficient training in several subject fields such as physics, chemistry, biology, earth science, etc., so that the teacher can give instruction in more than one of the sciences.

The very weak showing of pattern Number 1 in Table VIII, with a weight of 122, indicates that an overshelming majority of the administrators were flatly against this type of science teacher preparation. Such a program would provide a prospective science teacher with intensive training in one subject matter field of science such as physics or chemistry, and offer little or no training in other fields such as biology.

Patterns numbered 3 and 4 in Table VIII were generally little favored by the administrators. Either one or the other was ranked as fourth choice by one-third of the respondents. In their rejection of pattern Number 4, "Training in survey courses of science (physical or biological) followed by specialization in a single field of science such as physics, chemistry, etc.," administrators seem to express their doubts as to the adequacy or thoroughness of the survey course type of

---

[1] For exact wording of original statement, see Section VI A of the administrators' inventory in the Appendix.

training program for prospective teachers. Again, in their decisions against Number 3, which suggested equal division of training into two broad fields of science (such as physical and biological sciences), they apparently fear lack of thoroughness both within and without the fields of concentration. And along with these doubts they seem also to fear any narrowing, or limiting of training implicit in the confinement of science study to just two fields of science, however broadly treated, especially if one of these two fields is also the one selected for intensive specialization.

The implications of the administrators' response to this section of the questionnaire would seem to give a clear-cut picture of their conception of adequate subject matter training for science teachers.

The administrators seem unwilling that either breadth of subject coverage or depth of study within certain subjects be sacrificed to any great extent. They seem to desire that science teachers have a broad familiarity with the various fields of science, but that their knowledge, even in peripheral areas, should receive somewhat better grounding than the brief introductions which they apparently conceive the survey-type courses to provide. They appear to argue strongly for intensive cultivation of particular science fields, but at the same time to urge against narrow over-specialization by the exclusion of study in several other fields.

In final analysis, the responses to this part of the study indicate that the administrators in general have two positive convictions regarding the subject matter training of candidates for science teaching openings on their faculties. First, they want their teachers to be reasonably expert in at least one field of science but also to be capable of imparting valuable learnings in a variety of science fields. Secondly, the administrators want the degree of specialization in both varied general and in particular fields of science training to be such that a

teacher can teach courses in more than one field of science.

## G. PATTERNS OF STUDENT TEACHING

Practice in teaching has long been considered an essential element in the preparation of future teachers to meet the varied challenges of actual classroom operation. Accordingly, this part of the study was designed to determine what kind of student teaching the administrators would consider best for science teachers-in-training.

Three types of practice teaching situations were offered for judgment and the respondents were asked to rank these in the order of first, second, and third choices. Space was provided at the end of the section, and the administrators were invited to add their suggestions, criticisms, and comments concerning student teaching.

Table IX lists the three suggested patterns of student teaching as:

(1) In an ordinary teaching situation in the public schools, under the direction of an expert teacher.

(2) Under special training teachers in training schools.

(3) In an experimental-type classroom situation where the theories of modern education are applied to concrete situations.

Table IX offers a percentage-wise breakdown of the administrators' choices, but these alone fail to clarify the degrees of relative merit attributed to each of the three patterns of student teaching. In order to clarify the table a weight of 3 was assigned to the first choice, 2 to the second, and 1 to the third.

Thus, pattern Number 1 carries a weight of 262 points in comparison with Number 2 with 178, and Number 3 which trails with 141. It would seem that the large majority of administrators have indicated strong preference for one particular type of student teaching experience.

Table IX

Preferences of High School Administrators for Various Patterns of Student Teaching in the Science Teacher Training Program

| Pattern of Student Teaching | Per Cent of Administrators Who Rank Each Pattern as a: First Choice | Second Choice | Third Choice | Weighted Values |
|---|---|---|---|---|
| 1. In an ordinary teaching situation in the public schools, under the direction of an expert teacher | 74 | 17 | 6 | 262 |
| 2. Under special training teachers in training schools | 16 | 48 | 34 | 178 |
| 3. In an experimental classroom situation where the theories of modern education are applied to concrete situations | 10 | 34 | 43 | 141 |

| | Weights Assigned to the Administrators' Responses: First Choice | Second Choice | Third Choice | Total Weighting | Ranks on the Basis of Weighting |
|---|---|---|---|---|---|
| 1. In an ordinary teaching situation in the public schools, under the direction of an expert teacher | 222 | 34 | 6 | 262 | 1 |
| 2. Under special training teachers in training schools | 48 | 96 | 34 | 178 | 2 |
| 3. In an experimental classroom situation where the theories of modern education are applied to concrete situations | 30 | 68 | 43 | 141 | 3 |

Of the three patterns suggested, Number 1 (the first choice of the majority of administrators) will be seen as that pattern which would logically provide experience in a teaching situation most similar to the one which the prospective science teacher would meet on his first job. Conversely, the least favored pattern--that of a purely experimental-type school situation--appears to strike the administrators as being the least likely to provide experience which would be later applicable to professional teaching. On the basis of its position on the scale of weighted values, the generally selected second choice may be seen as the one for which administrators would be willing to settle as a substitute for the actual public school type of student teaching if the latter were unavailable to the trainee.

In summary, the major implications seen in the opinions of the administrators may be taken as the following: (1) that the most desirable kind of practical preparation for teaching is that received in the situation most similar to the one to be dealt with on the job; (2) that there is little practical value in student teaching which does not provide closely similar experience to the actual teaching assignment; (3) that it is important that student teachers receive expert direction during their practice period; (4) that it would be better to have this practice acquired under the guidance of special training teachers in training institutions than in experimental-type schools; and (5) that the administrators are not sure that the selective character of experimental schools and their populations would be such as to provide student teachers with experiences of use to them in filling positions on the faculties of non-experimental schools.

# CHAPTER IV

## A COMPARISON OF RESPONSES FROM DIFFERENT SEGMENTS OF THE ADMINISTRATIVE POPULATION

Since the responding administrators represented public, private, and parochial schools of various sizes, it seemed advisable to find out if any segment of this group held opinions differing significantly from those held by any other segments. Two comparisons were made, one with respect to the size of the schools and one with respect to the types of schools represented by the administrators cooperating in the study.

### A. COMPARISON OF ADMINISTRATOR RESPONSES WITH RESPECT TO SIZE OF SCHOOLS

Returns from the seventy-five smallest schools were compared with those from the fifty-five largest schools. In the smaller schools student enrollment ranged from 56 to 150 pupils, with the greater number of the schools enrolling fewer than 100 pupils. In the fifty-five larger schools under comparison enrollment ranged from 500 to 3416, with the pupil population of the majority falling at 750.

Comparisons were made of the responses from each of these two groups for each competency listed on the entire inventory entitled "What Do You Want in the Training of Science Teachers for Illinois High Schools?" Table X shows the results of these comparisons according to the size of schools regarding the selection of those competencies judged to be minimum essentials in the training program of science teachers.

The chi square test of homogeneity was used to separate responses showing significant differences in the judgments of large and small school administrators from those showing differences arising purely from chance. At the five per cent level only four competencies out of the entire inventory revealed a significant

Table X

Significant Differences of Judgments of Administrators of Small and Large High Schools on Competencies They Think Should Be Minimum Essentials in the Science Teacher Training Program

| Competencies | Per Cent of Administrators Selecting the Competency as a Minimum Essential | | Chi Square |
|---|---|---|---|
| | Small High Schools | Large High Schools | |
| 1. Skill in helping students to select and work out various science projects in connection with their science classwork | 37 | 64 | 7.383 |
| 2. Understanding the physical, mental, and social characteristics which affect the progress of all learners | 57 | 78 | 6.385 |
| 3. Skill in the communication of ideas | 72 | 89 | 5.764 |
| 4. Ability to locate and to interpret research in the fields of education and science teaching | 43 | 62 | 4.651 |

difference in the responses of administrators of small schools and those of large schools. These four competencies, listed in Table X, were:

(1) Skill in helping students to select and work out various science projects in connection with their science class work. (From Section I on Classroom Techniques in the administrators' inventory.)

(2) Understanding the physical, mental, and social characteristics which affect the progress of all learners. (From Section IV, "Understanding Boys and Girls.")

(3) Skill in the communication of ideas. (From Section V, "Other Aspects of Professional Training.")

(4) Ability to locate and to interpret research in the fields of education and science teaching. (This also came from Section V, "Other Aspects of

Professional Training.")

Table X presents differences in per cent between responses from small and large schools and the chi square figure for each of the four competencies selected. A chi square, to be significant at the five per cent level when one degree of freedom obtains, must equal or be larger than 3.841.[1]

The fact should be noted that only four items out of the list of forty-five competencies on the administrators' inventory showed any significant difference in responses related to size of schools. There seems to be in this fact the logical implication that most of the high school administrators who responded to this questionnaire held a rather common viewpoint of what a science teacher ought to be capable of doing and what kind of training he should have to enable him to do it.

The widest discrepancy in opinions of administrators from large and small schools arose over the question of a teacher's skill in helping students to select and work out various science projects in connection with their science class work. Sixty-four per cent of the administretors from large high schools held this skill to be so important that provision for it should be one of the minimum essentials in a science teacher's formal training program. Only thirty-seven per cent of the small high school administrators concurred in this opinion.

One possible explanation of this split in point of view may be seen in the fact that larger schools, as a general rule, have more elaborate and extensive laboratory and library facilities than do smaller schools. Thus, larger schools can provide wider opportunities for science project work in general. Again, in large schools, the student population may include greater numbers of youngsters planning to go to college and perhaps on to careers in science. In serving the interests of such a group of pupils the science teacher faces a genuine challenge.

---

[1] J. P. Guilford, Fundamental Statistics in Psychology and Education. New York: McGraw Hill Book Co., 1950. P. 611.

He must be able to devise projects which will give his pupils every opportunity for fruitful scientific study open to them through the greater facilities of a large school and the community it serves.

If it is a fact that, in general, larger schools have greater science facilities than do small schools and that their student populations include a greater proportion of pupils with specific interests in science courses, then it is not surprising that nearly two-thirds of the administrators of large high schools felt that skill in helping students select and work out science projects should be developed in the training of science teachers.

And if, on the other hand, it is a fact that smaller schools in general have fewer and more limited science facilities and a smaller proportion of students specifically interested in science courses, this might explain why only a minority (thirty-seven per cent) of the administrators of small high schools felt that skill in project guidance was an essential one for the beginning science teacher.

Nevertheless, the acceptance of the foregoing assumptions about school facilities and pupil interests implies all the greater need for a teacher trained in helping students work out science projects in small schools. For here, if educational opportunity in the small school is to be equalized with that in the larger schools, there is all the more need for ingenuity and creative science teaching both to stimulate learning and interest in the pupils and to make the most productive use of limited facilities.

The question of a science teacher's understanding of the physical, mental, and social characteristics which affect the progress of young people in school (see Table X, Item 2) prompted notable differences in responses from administrators of large high schools and from those in charge of small ones. Seventy-eight per cent of the respondents from large schools affirmed that this kind of understanding was so important that specific provision for its development should be an

absolute essential in the training program of the prospective science teacher. Only half of the administrators from small schools felt that such training in socio-psychological skills was indispensable for adequate teacher preparation.

However, it would be unwarranted to assume, on the basis of their responses, that these administrators of small schools did not consider it important for a teacher to be aware of the social and psychological factors influencing the learning progress of the pupils in their schools. Any school administrator is quick to recognize that a teacher alert and able to deal with these factors can be an invaluable addition to his staff.

It is more likely, then, that inherent differences in the schools themselves by virtue of their sizes may have caused the divergent opinions of their administrators. The large school is more likely to serve a wider community than will the small school. This increases the probability of a wider range of socio-economic differences in the student population. In turn, this implies more variation in learning capacities and learning progress among the pupils in any given classroom. It is self-evident that a teacher in such a classroom will have to deal with a greater variety of individual differences among his pupils than will the teacher whose pupils come from a small and fairly homogeneous community.

On the basis of differences in character of pupil population between large and small schools, it is possible to infer the reasoning behind the judgments of the administrators. While the superintendent of a small high school may value highly a teacher's ability to deal with pupil differences of socio-psychological origin, he may not feel that his school presents a sufficient array of such problems as to require specific prior training on the part of the science teacher. On the other hand, the man in charge of a large school may see in the ability to handle problems arising out of the varied character of the pupil population one of the first qualities he must look for in a candidate for a staff opening.

The last two questions on the administrators' inventory which provoked notably different responses (see Items 3 and 4 in Table X) seemed more to reflect shades of the same opinion rather than truly divergent views. In Item 3 of Table X, both segments of the administrative population asserted their strong approval of the development of skill in the communication of ideas as a minimum essential in the science teacher training program. And in turn, both groups were fairly lukewarm toward the inclusion as an essential in science teacher programs preparation for the ability to locate and to interpret research in the fields of education and science teaching (see Item 4, Table X). In both cases the differences in response came about through the distinctly higher percentage of administrators of large schools favoring the particular area of training in question. It is to be noted that this same high percentage of response from large school administrators favoring training school development of the two competencies above also occurred consistently throughout all four areas where differences of opinion were noted. Such consistency on the part of the administrators of large schools would seem to indicate a common viewpoint in this group. They seem to feel that the very size and complex character of a large school will present the science teacher with such an array of problems in the course of his daily work that he will need as much training for human understanding as he will require for purely academic competence.

In summary, then, two factors related to the size of schools may account for the four questions prompting significantly different responses from the administrators and also for the degrees of difference noted. The first and most significant factor is that of the character of student populations. Large schools may serve pupils coming from widely varied socio-economic backgrounds, with consequently diverse educational aims and capacities for learning. In contrast, the small school may serve pupils coming from a single type of socio-economic background. These pupils may also share common educational aims and have similar, or

at least less sharply varied, interests and capacities for learning than do classmates in a large school. This factor serves to complicate the job of a science teacher in a large school and, to a certain extent, to simplify his work in the small school.

The second factor related to school size has to do with the amount and quality of laboratory and library facilities available for science teaching. These may vary widely from those at hand in the small school to those available in large schools. And here the question of the value of a science teacher's prior training in project selection and guidance, for instance, may not be recognized until the feasibility of numerous and varied high school science projects has itself been established.

If the size of the school, and the qualities it has as a consequence of its size, determine to any extent what a teacher should know and be able to do, there must be certain implications in these factors for the future training of science teachers. For example, it is not likely that our society and its schools will grow more homogeneous and less complex. It is equally unlikely that teaching experience in a small school in a small community with limited facilities will alone provide the science teacher with the breadth of understanding he will need to meet adequately the manifold problems which any larger school may present to him.

Furthermore, if youngsters in small schools are to gain educational benefits equal to those offered pupils in large schools, they too must have competent, well-trained teachers.

The responses recorded in Table X clearly permit the inference that the larger the school, the more complex does the job of a science teacher become. And if this is the case, the more broadly trained and skillful must a teacher be to meet the demands of prospective employers. Taking all these factors into

consideration, the teacher-training institutions seem to be the logical place for the development of both academic skills and of the social and psychological understandings so necessary to competent teaching in any school, whatever its size.

## B. COMPARISON OF ADMINISTRATOR RESPONSE WITH RESPECT TO TYPE OF SCHOOL

Using the same procedure as described before, this second comparison utilized the responses from administrators of thirty-three private and parochial schools and those from administrators of two hundred sixty public schools. The chi square test of homogeneity was again used to determine whether the responses from these two groups of administrators differed significantly from one another. At the five per cent level only two competencies were found in the entire questionnaire on which the difference between responses from administrators of private and parochial schools and from administrators of public schools could not be attributed to chance. This means that on all the other competencies there was insufficient evidence to reject the hypothesis of homogeneity at the five per cent level. The two competencies on which there was a significant difference of opinion were:

(1) Ability to employ a wide range of teaching techniques. (From Section I, "Classroom Techniques," of the administrators' inventory.)

(2) Ability to work effectively with others in solving the problems of the school. (From same, Section V, "Other Aspects of Professional Training.")

Table XI gives the difference in per cent between responses from administrators of private, parochial, and public schools, and also the chi square for each of the two competencies. Here, again one degree of freedom obtains and a chi square of 3.841 or larger is necessary to permit the assertion that, at the five per cent level, the difference between responses is not due to a chance in sampling.

Table XI

Significant Differences of Judgments of Administrators of Private and Parochial Schools and Public Schools on Competencies They Think Should Be Minimum Essentials in the Teacher Training Program

| Competencies | Per Cent of Administrators Selecting the Competency as a Minimum Essential | | Chi Square |
|---|---|---|---|
| | Private and Parochial Schools | Public Schools | |
| 1. Ability to employ wide range of teaching techniques | 39.4 | 57.7 | 3.974 |
| 2. Ability to work effectively with others in solving the problems of the school | 45.4 | 66.9 | 5.8947 |

In one instance (see Item 1, Table XI) the difference seems almost negligible. Here a higher percentage of public school officers responded in favor of a wide range of teaching techniques as an essential measure of a science teacher's competence. Were the difference in responses more pronounced, it could possibly be readily explained through differences in the sizes and populations of the types of schools whose administrators replied. For example, private or parochial schools, generally smaller than public schools, usually draw their pupils from a particular segment of the population. If a wide range of teaching techniques is necessary only because of individual differences in the socio-economic or psychological characteristics of the student body, then it is understandable why public school administrators put a higher premium upon classroom versatility than do their private or parochial school colleagues.

But this conclusion must thereby have assumed a limited definition of a "wide range of teaching techniques," for the whole question of varied teaching techniques in relation to varieties of subject matter and various aspects of classroom procedure has been left open. We cannot infer from the small difference

recorded in the data whether some administrators in either the private type or public schools were responding in terms of pupil differences or in terms of subject matter and procedure, as requiring the variety of teaching techniques in question. The only legitimate inference which can be drawn is that based on the differences between the types of schools discernible from the way they were set up for comparison on the inventory.

On the second competency evoking different responses, there was a much wider split in point of view among private or parochial and public school administrators. This arose over the question of whether it is essential that a prospective science teacher be trained to develop the ability to work with others in solving the problems of the school (see Item 2, Table XI). Just over two-thirds of the public school respondents felt that such training was essential, while less than half of those responding from private or parochial schools held this to be the case.

It is difficult to draw conclusions on the basis of the above responses for two reasons. First, there is a greater variety of organizational systems among private and parochial schools, especially with respect to the formation of school policy and the delegation of authority and responsibility, than there obtains generally in publicly administered schools. Secondly, in many private and parochial schools the place of science in the curriculum is relatively secondary, so that the science teacher might not have much voice in matters of school policy.

On the assumption that in the case of private schools, the question of school policy and decision-making is more generally in the hands of a central authority than is the case in public schools, the responses to this question may be at least tentatively explained. For in this case, it is probable that more public school officers would desire their staff members to participate ably in the common effort to solve school problems.

## C. IMPLICATIONS OF THE COMPARISONS IN THIS STUDY

In line with the over-all aim of this study, the purpose in making the comparisons treated in this chapter was to discover what implications they might hold for science teachers and their training institutions. Beyond the particular implications treated under each question there may be two rather general conclusions. First, the size of a high school and the range of the general population which it serves is of far more significance to the science teacher and the training he will need than is the type of school, public or private, in which he will teach.

A second conclusion derivable from these comparisons is that the nature of the school and the elements in our society which it represents determine what a teacher must be able to do, and thus define the teaching role. This is seen clearly in the demands of public high school administrators for teachers trained in skills and understandings far beyond the scope of mere academic proficiency. It would seem that administrators, in their efforts to serve the needs of their communities, have largely come to require specific social and psychological training as essential in the preparation of teachers. This can only be the case if the needs of the school population are such that a teacher's skill must include a genuine breadth of human understanding to enable him to impart knowledge effectively to the children in the classroom. A majority of the administrators have expressed in their responses to this inventory just such social and educational needs.

Teacher training institutions are becoming aware that they cannot hope to prepare competent teachers on the basis of preconceived ideas about teaching and subjects taught. If they wish to serve society, they need only to listen where such educational needs and demands are most clearly expressed--in the public schools. If training institutions construct programs for future teachers on the basis of the social and educational needs expressed in the public schools, both

school and society, teachers, administrators, and above all, the young people should be better served.

# CHAPTER V

# THE TRAINING OF BEGINNING SCIENCE TEACHERS IN THE STATE OF ILLINOIS

## A. THE TEACHERS IN THE STUDY

As earlier described, this part of the study used the returns from 119 beginning science teachers. Of this group 46 had completed one year, 41 had completed two years, and 32, three years of teaching.

Where They Were Trained. Sixty-six of these teachers had been trained in teachers colleges; twenty-nine had received their training in universities; and twenty-four had done their preparatory work in liberal arts colleges. Thirteen teachers in the group had earned master's degrees.

Size of Schools Where They Were Employed. Seventy-eight per cent of these teachers had found employment in small high schools, enrolling fewer than 250 pupils (see Table XII). A breakdown of the returns indicates the following: thirty-two of the beginning science teachers were employed in high schools having fewer than 100 pupils; sixty-one teachers were at work in high schools enrolling between 100 and 249 pupils; ten were teaching in high schools which listed between 250 and 499 students; eleven taught in high schools that enrolled 500 to 999 students; and five teachers were employed in high schools with student populations of 1000 or more. In Chapter VI, which deals with the actual job of teaching which these individuals were carrying on at the time they were canvassed, the implications for adequate training to teach in a small school will be explored. However, it should be kept in mind, during the ensuing discussion of the training received by these beginning science teachers, that their first jobs will generally require them to teach at least more than one science subject and possibly some non-science subjects.

Table XII

Number of Science Teachers Out of 119 Reporting
Who Taught in Schools of Various Sizes

| Size of School<br>Schools Enrolling: | Number of Teachers of 119 Reporting Teaching in Schools of This Size | Per Cent of 119 Science Teachers Reporting Teaching in Schools of This Size |
|---|---|---|
| Less than 100 students | 32 | 27* |
| 100-249 students | 61 | 51 |
| 250-499 students | 10 | 8 |
| 500-999 students | 11 | 9 |
| 1000 or more students | 5 | 4 |

*All figures rounded off to nearest whole number

## B. FORMAL TRAINING

Out of the responses of the 119 beginning science teachers it is possible to view the number of teachers with or without training in the various fields reported (see Table XIII). It should be noted here the number of teachers reporting no training in biological sciences, chemistry, physics, educational psychology, tests and measurements and curriculum. More alarming perhaps is the reported number of minimum hours in each subject field found in Table XIII where the range in number of semester hours begins with figures as low as .5, 1.3, 2, and 2.6 semester hours of work. Suffice it to say that teachers with no more than the number of semester hours listed in these minimums scarcely have an insight into the field of study concerned and not enough to gain sufficient competence to teach or use it. On the other hand the maximum number of semester hours of training reported in the range of semester hours in the fields of biological science chemistry, physics, mathematics, home economics and agriculture show thorough grounding in these fields of study but this may be suggestive of poor balance in training to become a competent science teacher.

Table XIII

Number of Science Teachers Out of 119 Reporting
Who Are Trained in Various Fields of Science and Education,
Range in Semester Hours for Each Subject
and the Number of Teachers Without Training in Each Subject

| Subject Field | No. of Teachers with Training in This Subject or Field | No. of Teachers Who Reported No Training in This Subject or Field | Range in Sem. Hours for Those Teachers Who Have Training in This Subject or Field |
|---|---|---|---|
| Biological Science* | 112 | 7 | 2.6 - 74 |
| Chemistry | 97 | 22 | 2.6 - 60 |
| Physics | 90 | 29 | 2.6 - 55 |
| Mathematics | 86 | 33 | 2.6 - 45 |
| Geology | 28 | 91 | .5 - 8 |
| Meteorology | 17 | 102 | 2.0 - 37 |
| Astronomy | 15 | 104 | .5 - 5 |
| Science Survey | 14 | 105 | 1.3 - 8 |
| Home Economics | 11 | 108 | 2.6 - 48 |
| Agriculture | 9 | 110 | 2.6 - 70 |
| Educational Psychology | 115 | 4 | 2.0 - 24 |
| Practice Teaching | 114 | 5 | 2.6 - 10.6 |
| Other Courses in Education | 111 | 8 | 2.0 - 23.3 |
| Tests and Measurements | 56 | 63 | 2.0 - 19 |
| Curriculum | 30 | 89 | 1.3 - 33 |

*Biological Science includes biology, zoology, botany, physiology and bacteriology.

From the responses of the 119 beginning science teachers it is possible to construct a composite picture of the training received by science teachers in the State of Illinois.

Table XIV

Composites Showing the Median Semester Hours and Average Semester Hours of Training in Various Fields of Study for the 119 Science Teachers Reporting

| Field of Study | Approximate Average Number of Semester Hours of Study | Median Semester Hours of Study |
|---|---|---|
| All Sciences | 47 | 41 |
| All Education Courses | 24 | 21 |
| Physics | 10 | 8 |
| Chemistry | 14 | 12 |
| Biological Science | 19 | 15 |
| Other Sciences* | 4 | 0 |
| Practice Teaching | 6 | 5.3 |
| Tests and Measurements | 1.5 | 0 |
| Educational Psychology | 4 | 3 |
| Curriculum | 1 | 0 |
| Other Courses in Education | 11 | 5.3 |

*Other sciences includes geology, meteorology, astronomy and science survey courses.

If the total number of semester hours of training in various fields of these beginning science teachers is divided by 119, a composite picture of the average number of semester hours of training in each field is obtained. The beginning science teacher averages approximately forty seven semester hours of science

training and twenty four semester hours of training in the field of education. Training in the field of science is comprised of approximately ten semester hours in physics, fourteen semester hours in chemistry, nineteen semester hours in the biological sciences and the remainder in other sciences. Training in the field of education is comprised of approximately six semester hours in practice teaching, one and one half semester hours in tests and measurements, four semester hours in educational psychology, one semester hour in curriculum and eleven plus semester hours in other courses in education.

On the other hand if the median number of semester hours of training in various fields of these beginning science teachers is used, a different composite picture is obtained. Using this method a beginning science teacher has a median of forty-one semester hours of training in science and twenty-one semester hours in the field of education. Training in the field of science shows a median of eight semester hours of training in physics, twelve semester hours in chemistry, fifteen semester hours in the biological sciences and zero semester hours in other sciences. Training in the field of education shows a median of five and three tenths semester hours in practice teaching, zero semester hours in tests and measurements, three semester hours in educational psychology, zero semester hours in curriculum and five and three tenths semester hours in other courses in education. Of course none of the 119 beginning science teachers fits the average or median composite picture in every field listed. But many subject-matter specialists would be quick to point out that eight semester hours of physics, three semester hours of educational psychology or twelve semester hours of chemistry are inadequate for preparing the beginning science teacher for his work.

This composite reveals severe inadequacies in some areas, but it is only fair to point out that such a composite can be very misleading. Tables XIII and XIV will help to clarify the picture by presenting a breakdown of the training of the

beginning science teachers according to the median number and range of hours of work taken in each field.

It is important to note (Table XIII) the number of teachers out of the 119 reporting who had had no training in such basic fields as physics, chemistry, and biology, and the number of teachers who lack training in tests and measurement, and curriculum development.

The importance of training in curriculum development to the beginning science teacher can be seen in the responses of the administrators relevant to this question. In Table VII fifty-six per cent of the administrators are seen to favor training for dealing with high school curriculum problems (see Item 7) as a minimum essential in the science teacher training program. Another forty per cent of this group held such training to be important and should be included in the science teacher program if possible. In the light of such strong administrative demand for competency in curriculum work, it is clear that science teachers are not being prepared for the job expected of them.

## C. TRAINING IN THE SUBJECT MATTER OF SCIENCE

The majors carried in the training programs reported by the 119 science teachers range over sixteen subject matter fields. Table XV shows the number of teachers majoring in the various fields. It is worth noting that only fifty-nine of these teachers (about forty-nine per cent of the total group) majored in a field of science.

The Beginning Physics Teachers. Out of all the science teachers reporting, forty-eight had taught physics. This group of forty-eight teachers had taken from 16 to 112.6 semester hours of science courses during their training. The median for these forty-eight teachers is 48.3 semester hours of science. In physics they reported a range of from 8 to 55 hours of training, with the median falling at 16 semester hours. Only thirteen teachers in this group (about twenty-five per cent)

Table XV

Number of Science Teachers out of 119 Reporting Having Majors in the Various Subject-Matter Fields

| Subject-Matter Field | Number of Science Teachers with Majors in This Subject Field |
|---|---|
| Biology | 21 |
| Chemistry | 16 |
| Zoology | 6 |
| General Science | 6 |
| Physics | 5 |
| Physical Science | 6 |
| Botany | 1 |
| Mathematics | 24 |
| Physical Education | 18 |
| Agriculture | 5 |
| Home Economics | 4 |
| Social Science | 2 |
| Industrial Arts | 2 |
| English | 1 |
| Education | 1 |
| Music | 1 |

of forty-eight had majored in physics.

Of particular interest at this point are the records of six beginning physics teachers appearing in Table XVI as Numbers 6, 30, 33, 34, 37, and 41. With the exception of Number 34 (22 hours) each one of them has 24 or more semester hours of training in the physics field. Taken as a group, their physics training, then, amounts to seventy per cent or more of the total semester hours of science training that these teachers have had. Further inspection of Table XVI will show that the training these teachers received in the other major fields of science is extremely meager.

Table XVI

Semester Hours of Science Training as Reported by 48 Beginning Physics Teachers

| No. | Inventory Number | Total Semester Hours of: Science | Physics | Chemistry | Biology | Other Science |
|---|---|---|---|---|---|---|
| 1. | 72 | 112.6 | 49.3 | 24.6 | 3.3 | 35.6 |
| 2. | 102 | 95.3 | 10.6 | 8 | 74 | 2.6 |
| 3. | 51 | 85 | 10 | 26 | 49 | 0 |
| 4. | 77 | 82.6 | 10.6 | 16 | 56 | 0 |
| 5. | 58 | 80 | 10 | 22 | 48 | 0 |
| 6. | 13 | 79 | 55 | 10 | 0 | 14 |
| 7. | 78 | 74 | 16 | 30 | 28 | 0 |
| 8. | 76 | 73.3 | 10.6 | 38.6 | 21.3 | 2.6 |
| 9. | 4 | 65 | 15 | 8 | 5 | 37 |
| 10. | 39 | 65 | 24 | 35 | 3 | 3 |
| 11. | 107 | 62.6 | 8 | 18.6 | 35.3 | 0 |
| 12. | 20 | 61.3 | 16* | 24 | 21.3 | 0 |
| 13. | 90 | 60 | 18.6 | 25.3 | 16 | 0 |
| 14. | 83 | 58.6 | 16 | 32 | 8 | 2.6 |
| 15. | 93 | 58.6 | 8 | 45.3 | 5.3 | 0 |
| 16. | 111 | 58.6 | 34.6 | 8 | 5.3 | 10.6 |
| 17. | 19 | 58 | 12 | 13 | 24 | 9 |
| 18. | 119 | 58 | 10 | 24 | 24 | 0 |
| 19. | 91 | 56 | 10.6 | 40 | 2.6 | 0 |
| 20. | 87 | 55 | 27 | 18 | 7.5 | 2.5 |
| 21. | 96 | 54 | 19.5 | 23.5 | 11 | 0 |
| 22. | 27 | 53.3 | 26.6 | 16 | 10.6 | 0 |
| 23. | 69 | 53 | 22 | 21 | 10 | 0 |
| 24. | 36 | 48.3* | 8 | 21.3 | 16.6 | 2.3 |
| 25. | 29 | 48 | 10 | 26 | 12 | 0 |
| 26. | 25 | 42 | 12 | 10 | 16 | 4 |
| 27 | 101 | 41 | 9 | 19 | 10 | 3 |
| 28 | 55 | 40 | 15 | 25 | 0 | 0 |
| 29. | 40 | 38.6 | 24.6 | 10.6 | 3.3 | 0 |
| 30. | 70 | 34.6 | 29.3 | 5.3 | 0 | 0 |
| 31. | 44 | 34 | 8 | 12 | 12 | 2 |
| 32. | 66 | 34 | 16.6 | 8 | 9.3 | 0 |
| 33. | 42 | 32 | 24 | 0 | 2.6 | 5.3 |
| 34. | 45 | 32 | 22 | 10 | 0 | 0 |
| 35. | 84 | 32 | 16 | 0 | 10.6 | 5.3 |
| 36. | 113 | 31.3 | 16 | 8 | 3.3 | 4 |
| 37. | 53 | 31 | 25.6 | 0 | 2.6 | 2.6 |
| 38. | 59 | 30.6 | 8 | 14.6 | 0 | 8 |
| 39. | 114 | 29.3 | 16 | 8 | 5.3 | 0 |
| 40. | 57 | 29 | 16 | 5 | 8 | 0 |
| 41. | 118 | 26.6 | 24 | 0 | 2.6 | 0 |
| 42. | 1 | 24.6 | 18 | 3.3 | 3.3 | 0 |
| 43. | 64 | 24.6 | 18.6 | 0 | 6 | 0 |
| 44. | 71 | 24.6 | 13.3 | 8 | 3.3 | 0 |
| 45. | 24 | 24 | 12 | 6 | 6 | 0 |
| 46. | 12 | 23.3 | 16 | 0 | 3.3 | 4 |
| 47. | 115 | 19 | 11 | 8 | 0 | 0 |
| 48. | 5 | 16 | 8 | 0 | 8 | 0 |

*median

Yet, it is known that the beginning teacher is generally called upon to teach these other subjects. The significance of such a narrow scope of training will become abundantly clear when, in Chapter VI, section A, the reports of the beginning teachers of the actual range of subjects they were teaching will be analyzed. Also in Chapter VI these training records, together with the teachers' reports of their work will be examined in the light of the administrators' views on the quality of subject matter training necessary for competent science teaching. It will then become evident almost beyond question that present science training programs for teachers are seriously inadequate and that their revision is imperative. Furthermore, if one supports the opinions that (a) a science teacher should have a minimum of 60 semester hours of training in science,[1] and (b) that a teacher of physics is better trained when he also has some preparation in chemistry, biology, and other related sciences, then on this basis alone it becomes clear that these physics teachers were inadequately trained.

The Beginning Chemistry Teachers. Thirty-seven teachers from among the 119 in the study had taught chemistry. Table XVII indicates the range of their training in science to have been from 25 to 112.6 semester hours, with the median for the group falling at 56 semester hours. Their training in chemistry ranged from 8 to 49.3 semester hours, and in this case the median was found to be 23.5 hours. Eleven, or nearly thirty per cent, of the beginning chemistry teachers had too few hours in chemistry to constitute a chemistry major in the state of Illinois. Another thirty per cent of this group took less hours than are required for a minor in chemistry in the state of Illinois. Four teachers in this group had no training in physics and three of them lacked any training in biology. Fifteen of

---

[1]The Cooperative Committee on Science Teaching, "The Preparation of High School Science Teachers," School Science and Mathematics, 42:636-650, October, 1942; p. 647.

Table XVII

Semester Hours of Science Training

as Reported by 37 Beginning Chemistry Teachers

| No. | Inventory Number | Total Semester Hours of: Science | Chemistry | Biology | Physics | Other Science |
|---|---|---|---|---|---|---|
| 1. | 72 | 112.6 | 24.6 | 3.3 | 49.3 | 35.3 |
| 2. | 102 | 95.3 | 8 | 74 | 10.6 | 2.6 |
| 3. | 63 | 92.3 | 48 | 21.3 | 16 | 8 |
| 4. | 51 | 85 | 26 | 49 | 10 | 0 |
| 5. | 100 | 85 | 8 | 77 | 0 | 0 |
| 6. | 75 | 76.6 | 49.3 | 0 | 25.3 | 2 |
| 7. | 65 | 76 | 28 | 46 | 2 | 0 |
| 8. | 78 | 74 | 30 | 28 | 16 | 0 |
| 9. | 79 | 67 | 23 | 34 | 10 | 0 |
| 10. | 68 | 66 | 26 | 32 | 8 | 0 |
| 11. | 39 | 65 | 35 | 3 | 24 | 3 |
| 12. | 107 | 63 | 16.6 | 38 | 8 | 0 |
| 13. | 81 | 62 | 15 | 37 | 10 | 0 |
| 14. | 85 | 60 | 17 | 39 | 4 | 0 |
| 15. | 90 | 60 | 25.3 | 16 | 18.6 | 0 |
| 16. | 93 | 58.6 | 45.3 | 5.3 | 8 | 0 |
| 17. | 19 | 58 | 13 | 24 | 12 | 9 |
| 18. | 91 | 56* | 40 | 2.6 | 10.6 | 2.6 |
| 19. | 87 | 55 | 18 | 7.5 | 27 | 2.5 |
| 20. | 96 | 54 | 23.5* | 11 | 19.5 | 0 |
| 21. | 69 | 53 | 21 | 10 | 22 | 0 |
| 22. | 23 | 52 | 16 | 28 | 8 | 0 |
| 23. | 54 | 52 | 36 | 16 | 0 | 0 |
| 24. | 17 | 51 | 15 | 31 | 5 | 0 |
| 25. | 41 | 50.5 | 31 | 4 | 13 | 2.5 |
| 26. | 36 | 48.3 | 31.3 | 20.6 | 8 | 2.6 |
| 27. | 26 | 48 | 24 | 21.3 | 0 | 2.6 |
| 28. | 29 | 48 | 26 | 12 | 10 | 0 |
| 29. | 82 | 47 | 21 | 18 | 8 | 0 |
| 30. | 16 | 46 | 17.5 | 11 | 17.5 | 0 |
| 31. | 101 | 41 | 19 | 10 | 9 | 3 |
| 32. | 55 | 40 | 25 | 0 | 15 | 0 |
| 33. | 98 | 40 | 18 | 3 | 18 | 1 |
| 34. | 44 | 34 | 12 | 12 | 8 | 2 |
| 35. | 112 | 34 | 18 | 6 | 8 | 2 |
| 36. | 8 | 32 | 16 | 8 | 8 | 0 |
| 37. | 106 | 25 | 25 | 0 | 0 | 0 |

*median

the beginning chemistry teachers (approximately forty per cent of this group) were found to have had more training in other fields of science than they had had in chemistry. Roughly sixty per cent of the chemistry teachers had had less than the 60 semester hours of science training recommended by the Cooperative Committee on Science Teaching of the A. A. A. S.[2]

In terms of breadth of preparation, the training in science subject matter of those teaching chemistry would seem to be somewhat superior to that of those teaching physics. Nevertheless, their training will be seen in a subsequent discussion to be far from adequate in the light of what teachers and administrators have had to say about the actual job of high school science teaching in Illinois.

The Beginning Biology Teachers. Sixty-three, or better than half of the 119 teachers reached in this study, had taught biology. Their range of training in science subject matter was found to be from 12 to 95.3 semester hours, with the median point at 47 hours (see Table XVIII). In the field of biology these teachers had received from 2.6 to 77 semester hours of training, the median falling at 24.6 hours. Of the sixty-three teachers in this group, fourteen were without training in chemistry, and twenty-three lacked any training in physics. Eleven had taken neither physics nor chemistry during their training. It was also discovered that eighteen of the biology teachers had carried less than a minor in biology during their training period.

Biology training, as defined in this study, would constitute any course work taken in the following: general biology, zoology, botany, ecology, bacteriology, and physiology. Table XIX shows quite clearly that training for many biology teachers was not uniformly distributed over the field of biology. Their records reveal that some teachers lack zoology training; others have no credits in botany, and some have only negligible amounts of training in either field, compared to

---

[2] Ibid, p. 647.

## Table XVIII

### Semester Hours of Science Training as Reported by 63 Beginning Biology Teachers

| No. | Inventory Number | Total Semester Hours of: | | | | |
|---|---|---|---|---|---|---|
| | | Science | Biology | Chemistry | Physics | Other Science |
| 1. | 102 | 95.3 | 74 | 8 | 10.6 | 2.6 |
| 2. | 63 | 93.3 | 21.3 | 48 | 16 | 8 |
| 3. | 51 | 85 | 49 | 26 | 10 | 0 |
| 4. | 100 | 85 | 77 | 8 | 0 | 0 |
| 5. | 77 | 82.6 | 56 | 76 | 10.6 | 0 |
| 6. | 58 | 80 | 48 | 22 | 10 | 0 |
| 7. | 65 | 76 | 46 | 2 | 28 | 0 |
| 8. | 78 | 74 | 28 | 30 | 16 | 0 |
| 9. | 76 | 73.3 | 21.3 | 38.6 | 10.6 | 2.6 |
| 10. | 28 | 72.3 | 36 | 29.3 | 5.3 | 2.6 |
| 11. | 43 | 72 | 31 | 28 | 8 | 5 |
| 12. | 35 | 70 | 48 | 15 | 0 | 7 |
| 13. | 89 | 69.6 | 59 | 2.6 | 5.3 | 2.6 |
| 14. | 38 | 66 | 27 | 26 | 13 | 0 |
| 15. | 68 | 66 | 32 | 26 | 8 | 0 |
| 16. | 73 | 66 | 43 | 10 | 10 | 3 |
| 17. | 94 | 63.6 | 21.3 | 34.3 | 8 | 0 |
| 18. | 85 | 63 | 42 | 17 | 4 | 0 |
| 19. | 107 | 62.6 | 38 | 16.6 | 8 | 0 |
| 20. | 18 | 62 | 38 | 16 | 8 | 0 |
| 21. | 20 | 61.3 | 21.3 | 24 | 16 | 0 |
| 22. | 81 | 61 | 36 | 15 | 10 | 0 |
| 23. | 19 | 58 | 24 | 13 | 12 | 9 |
| 24. | 60 | 53.3 | 37.3 | 8 | 8 | 0 |
| 25. | 99 | 53.3 | 34.6 | 8 | 8 | 2.6 |
| 26. | 69 | 53 | 10 | 21 | 22 | 0 |
| 27. | 23 | 52 | 28 | 16 | 8 | 0 |
| 28. | 54 | 52 | 16 | 36 | 0 | 0 |
| 29. | 14 | 51 | 28 | 13 | 10 | 0 |
| 30. | 17 | 51 | 31 | 15 | 5 | 0 |
| 31. | 92 | 50 | 30 | 22 | 8 | 0 |
| 32. | 30 | 47* | 36 | 3 | 0 | 8 |
| 33. | 82 | 47 | 18 | 21 | 8 | 0 |
| 34. | 25 | 42 | 16 | 10 | 12 | 4 |
| 35. | 31 | 41.3 | 34.6 | 0 | 2.6 | 4 |
| 36. | 61 | 40 | 13.3 | 16 | 2.6 | 8 |
| 37. | 48 | 37.3 | 19.3 | 15.3 | 2.6 | 0 |
| 38. | 108 | 37.3 | 29.3 | 8 | 0 | 0 |
| 39. | 116 | 35 | 12 | 11 | 9 | 3 |
| 40. | 44 | 34 | 12 | 12 | 8 | 2 |
| 41. | 8 | 32 | 8 | 16 | 8 | 0 |
| 42. | 32 | 31 | 15 | 12 | 0 | 4 |
| 43. | 53 | 31 | 2.6 | 0 | 25.6 | 2.6 |
| 44. | 88 | 30 | 30 | 0 | 0 | 0 |
| 45. | 10 | 29.3 | 16 | 13.3 | 0 | 0 |

Table XVIII (Continued)

| No. | Inventory Number | Total Semester Hours of: Science | Biology | Chemistry | Physics | Other Science |
|---|---|---|---|---|---|---|
| 46. | 11 | 29 | 10 | 13 | 0 | 6 |
| 47. | 6 | 28.6 | 24.6* | 4 | 0 | 0 |
| 48. | 67 | 28 | 25 | 3 | 0 | 0 |
| 49. | 110 | 27 | 27 | 0 | 0 | 0 |
| 50. | 62 | 26.6 | 24 | 0 | 0 | 2.6 |
| 51. | 9 | 25.3 | 21.3 | 0 | 0 | 4 |
| 52. | 33 | 24.6 | 16.6 | 0 | 8 | 0 |
| 53. | 24 | 24 | 6 | 6 | 12 | 0 |
| 54. | 104 | 23 | 10 | 10 | 0 | 3 |
| 55. | 105 | 23 | 17 | 0 | 0 | 6 |
| 56. | 80 | 22.3 | 8 | 9.3 | 2 | 3 |
| 57. | 21 | 22 | 22 | 0 | 0 | 0 |
| 58. | 15 | 21 | 21 | 0 | 0 | 0 |
| 59. | 2 | 20 | 16 | 0 | 0 | 4 |
| 60. | 52 | 20 | 20 | 0 | 0 | 0 |
| 61. | 56 | 19 | 3 | 5 | 0 | 11 |
| 62. | 34 | 17 | 17 | 0 | 0 | 0 |
| 63. | 22 | 12 | 12 | 0 | 0 | 0 |

*median

Table XIX

Semester Hours of Training in Zoology, Botany, Physiology, Bacteriology, Ecology, and General Biology for 63 Beginning Biology Teachers

| No. | Inventory Number | Field of Biology | Total Semester Hours of Training in: Zool. | Botany | Physio. | Bacterio. | Ecol. | Gen.Bio. |
|---|---|---|---|---|---|---|---|---|
| 1. | 100 | 77 | 38 | 19 | 4 | 4 | 8 | 4 |
| 2. | 102 | 74 | 43.3 | 20 | 5.3 | 0 | 5.3 | 0 |
| 3. | 89 | 59 | 37.6 | 10.6 | 2.6 | 2.6 | 2.6 | 2.6 |
| 4. | 77 | 56 | 32 | 16 | 2.6 | 2.6 | 2.6 | 0 |
| 5. | 51 | 49 | 24 | 19 | 6 | 0 | 0 | 0 |
| 6. | 35 | 48 | 12 | 31 | 0 | 5 | 0 | 0 |
| 7. | 58 | 48 | 35 | 10 | 0 | 3 | 0 | 0 |
| 8. | 65 | 46 | 18 | 17 | 0 | 7 | 0 | 4 |
| 9. | 73 | 43 | 0 | 13 | 0 | 5 | 4 | 21 |
| 10. | 85 | 42 | 24 | 6 | 4 | 4 | 4 | 0 |
| 11. | 18 | 38 | 34.6 | 5.3 | 2.6* | 5.3 | 0 | 0 |
| 12. | 107 | 38 | 30 | 5.3 | 0 | 0 | 0 | 0 |
| 13. | 60 | 37.3 | 26.6 | 8 | 0 | 2.6 | 0 | 0 |
| 14. | 28 | 36 | 13.3 | 10.6 | 1.3 | 2.6 | 2.6 | 5.3 |
| 15. | 30 | 36 | 6 | 14 | 0 | 8 | 0* | 8 |
| 16. | 81 | 36 | 10 | 10 | 8 | 5 | 3 | 0 |

Table XIX (Continued)

| No. | Inventory Number | Field of Biology | Total Semester Hours of Training in: Zool. | Botany | Physio. | Bacterio. | Ecol. | Gen. Bio. |
|---|---|---|---|---|---|---|---|---|
| 17. | 31 | 34.6 | 8 | 13.3 | 2.6 | 2.6 | 0 | 8 |
| 18. | 99 | 34.6 | 0 | 10.6 | 2.6 | 0 | 0 | 21.3 |
| 19. | 68 | 32 | 0 | 0 | 0 | 4 | 4 | 24 |
| 20. | 17 | 31 | 22 | 9 | 0 | 0 | 0 | 0 |
| 21. | 43 | 31 | 24 | 4 | 3 | 0 | 0 | 0 |
| 22. | 88 | 30 | 8 | 8 | 3 | 0 | 0 | 11 |
| 23. | 108 | 29.3 | 21.3 | 0 | 2.6 | 2.6 | 2.6 | 0 |
| 24. | 14 | 28 | 28 | 0 | 0 | 0 | 0 | 0 |
| 25. | 23 | 28 | 14 | 0 | 8 | 0 | 0 | 6 |
| 26. | 78 | 28 | 12 | 6 | 4 | 6 | 0 | 0 |
| 27. | 38 | 27 | 3 | 4 | 4 | 6 | 0 | 10 |
| 28. | 110 | 27 | 6 | 3 | 6 | 3 | 0 | 9 |
| 29. | 67 | 25 | 5 | 5* | 10 | 0 | 0 | 5 |
| 30. | 6 | 24.6* | 8* | 6.6 | 0 | 0 | 0 | 10 |
| 31. | 19 | 24 | 6 | 6 | 3 | 3 | 0 | 6 |
| 32. | 62 | 24 | 16 | 0 | 0 | 0 | 0 | 8 |
| 33. | 21 | 22 | 3 | 3 | 10 | 0 | 0 | 6 |
| 34. | 9 | 21.3 | 2.6 | 0 | 2.6 | 0 | 0 | 16 |
| 35. | 20 | 21.3 | 8 | 2.6 | 0 | 2.6 | 0 | 8 |
| 36. | 63 | 21.3 | 0 | 0 | 0 | 2.6 | 0 | 18.6 |
| 37. | 76 | 21.3 | 8 | 13.3 | 0 | 0 | 0 | 0 |
| 38. | 94 | 21.3 | 0 | 16 | 2.6 | 2.6 | 0 | 0 |
| 39. | 15 | 21 | 8 | 8 | 0 | 5 | 0 | 0 |
| 40. | 52 | 20 | 5 | 5 | 10 | 0 | 0 | 0 |
| 41. | 92 | 20 | 4 | 4 | 6 | 6 | 0 | 0 |
| 42. | 48 | 19.3 | 5.3 | 3.3 | 6 | 2* | 0 | 2.6 |
| 43. | 82 | 18 | 10 | 8 | 0 | 0 | 0 | 0 |
| 44. | 34 | 17 | 8 | 3 | 3 | 0 | 3 | 0 |
| 45. | 105 | 17 | 3 | 4 | 0 | 0 | 0 | 10 |
| 46. | 33 | 16.6 | 3.3 | 3.3 | 3.3 | 0 | 0 | 6.6 |
| 47. | 2 | 16 | 8 | 0 | 8 | 0 | 0 | 0 |
| 48. | 10 | 16 | 0 | 0 | 2.6 | 2.6 | 0 | 10.6 |
| 49. | 25 | 16 | 6 | 4 | 0 | 6 | 0 | 0 |
| 50. | 54 | 16 | 5 | 8 | 3 | 0 | 0 | 0 |
| 51. | 32 | 15 | 4 | 4 | 4 | 3 | 0 | 0 |
| 52. | 61 | 13.3 | 0 | 8 | 0 | 0 | 0 | 5.3 |
| 53. | 22 | 12 | 3 | 3 | 3 | 0 | 0 | 3 |
| 54. | 44 | 12 | 8 | 0 | 0 | 0 | 0 | 4 |
| 55. | 116 | 12 | 3 | 3 | 3 | 3 | 0 | 0 |
| 56. | 11 | 10 | 0 | 3 | 4 | 3 | 0 | 0 |
| 57. | 69 | 10 | 5 | 5 | 0 | 0 | 0 | 0 |
| 58. | 104 | 10 | 4 | 3 | 0 | 3 | 0 | 0 |
| 59. | 8 | 8 | 0 | 4 | 4 | 0 | 0 | 0 |
| 60. | 80 | 8 | 0 | 0 | 0 | 0 | 0 | 8 |
| 61. | 24 | 6 | 0 | 2 | 0 | 1 | 0 | 3 |
| 62. | 56 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| 63. | 53 | 2.6 | 0 | 0 | 0 | 0 | 0 | 2.6 |

*median

their credits in other areas of biology.

Sixty-five per cent of the biology teachers were found to fall short of the recommended 60 hours of science training.[3] Tables XVIII and XIX present a tabulated summary of the foregoing discussion.

The Beginning General Science Teachers. Eighty-one of the 119 teachers reporting on this study had taught general science. Since, by definition, general science is a field of more than one science subject, sound training would presumably require a breadth of training. It is, therefore, interesting to note that these eighty-one teachers who had taught general science had carried a broader variety of major science subjects in their training programs than the teachers of the more specialized sciences had carried. The distribution of the majors these teachers carried runs as follows: thirty-one in biology; twenty-six in chemistry; and twelve in physics. Thirteen individuals in this group reported majors in two science subject fields, and one claimed majors in three fields of science. But it was also discovered (see Table XX) that twenty-two teachers had not majored in any science subject-matter field.

The range of training in science subjects was found to be from 16 to 112.6, with a median of 48 semester hours. In the field of biology the range for these eighty-one general science teachers was from 0 to 77 semester hours, with a median of 15. They received credits in the field of chemistry for from 0 to 45.3 semester hours. The median here was also 15. In physics the range reported was from 0 to 55 semester hours with 10 hours as the median. In all other science subject matter fields, not including biology, physics, or chemistry, the range was from 0 to 37 hours of credit, with the median falling at 0.

Inspection of Table XX will reveal that four of these eighty-one teachers had

---

[3] Ibid.

Table XX

Semester Hours of Science Training as Reported by 81 Beginning General Science Teachers

| No. | Inventory Number | Total Semester Hours of: Science | Biology | Chemistry | Physics | Other Science |
|---|---|---|---|---|---|---|
| 1. | 72 | 112.6 | 3.3 | 24.6 | 49.3 | 35.3 |
| 2. | 102 | 95.3 | 74 | 8 | 10.6 | 2.6 |
| 3. | 51 | 85 | 49 | 26 | 10* | 0* |
| 4. | 100 | 85 | 77 | 8 | 0 | 0 |
| 5. | 77 | 82.6 | 56 | 16 | 10.6 | 0 |
| 6. | 58 | 80 | 48 | 22 | 10 | 0 |
| 7. | 13 | 79 | 0 | 10 | 55 | 14 |
| 8. | 65 | 76 | 46 | 0 | 18.6 | 0 |
| 9. | 76 | 73.3 | 21.3 | 38.6 | 10.6 | 2.6 |
| 10. | 28 | 72.3 | 36 | 29.3 | 5.3 | 2.6 |
| 11. | 43 | 72 | 31 | 28 | 8 | 5 |
| 12. | 70 | 70 | 48 | 15* | 0 | 7 |
| 13. | 68 | 66 | 32 | 26 | 8 | 0 |
| 14. | 4 | 65 | 5 | 8 | 15 | 37 |
| 15. | 78 | 64 | 28 | 30 | 16 | 0 |
| 16. | 94 | 63.6 | 21.3 | 34.3 | 8 | 0 |
| 17. | 85 | 63 | 42 | 17 | 4 | 0 |
| 18. | 107 | 62.6 | 38 | 16.6 | 8 | 0 |
| 19. | 81 | 62 | 37 | 15 | 10 | 0 |
| 20. | 20 | 61.3 | 21.3 | 24 | 16 | 0 |
| 21. | 50 | 60 | 40 | 15 | 5 | 0 |
| 22. | 90 | 60 | 16 | 25.3 | 18.6 | 0 |
| 23. | 83 | 58.6 | 8 | 32 | 16 | 2.6 |
| 24. | 93 | 58.6 | 5.3 | 45.3 | 8 | 0 |
| 25. | 111 | 58.6 | 5.3 | 8 | 34.6 | 10.6 |
| 26. | 19 | 58 | 24 | 13 | 12 | 9 |
| 27. | 119 | 58 | 24 | 24 | 10 | 0 |
| 28. | 91 | 56 | 5.3 | 40 | 10.6 | 2.6 |
| 29. | 87 | 55 | 10 | 18 | 27 | 0 |
| 30. | 54 | 54 | 18 | 36 | 0 | 0 |
| 31. | 96 | 54 | 11 | 23.5 | 19.5 | 0 |
| 32. | 27 | 53.3 | 10.6 | 16 | 26.6 | 0 |
| 33. | 60 | 53.3 | 37.3 | 8 | 8 | 0 |
| 34. | 99 | 53.3 | 34.6 | 8 | 8 | 2.6 |
| 35. | 69 | 53 | 10 | 12 | 22 | 0 |
| 36. | 14 | 51 | 28 | 13 | 10 | 0 |
| 37. | 17 | 51 | 31 | 15 | 5 | 0 |
| 38. | 41 | 50.5 | 4 | 31 | 13 | 2.5 |
| 39. | 92 | 50 | 20 | 22 | 8 | 0 |
| 40. | 36 | 48.3 | 16.6 | 21.3 | 8 | 2.3 |
| 41. | 29 | 48* | 12 | 26 | 10 | 0 |
| 42. | 30 | 47 | 36 | 3 | 0 | 8 |
| 43. | 82 | 47 | 18 | 21 | 8 | 0 |
| 44. | 109 | 47 | 18 | 10 | 10 | 9 |

Table XX (Continued)

| No. | Inventory Number | Total Semester Hours of: Science | Biology | Chemistry | Physics | Other Science |
|---|---|---|---|---|---|---|
| 45. | 117 | 47 | 28 | 5 | 10 | 4 |
| 46. | 16 | 46 | 11 | 17.5 | 17.5 | 0 |
| 47. | 74 | 45.3 | 2.6 | 16 | 24 | 2.6 |
| 48. | 95 | 45.3 | 10.6 | 32 | 0 | 2.6 |
| 49. | 31 | 41.3 | 34.6 | 0 | 2.6 | 4 |
| 50. | 101 | 41 | 10 | 19 | 9 | 3 |
| 51. | 55 | 40 | 0 | 25 | 15 | 0 |
| 52. | 61 | 40 | 13.3 | 16 | 2.6 | 8 |
| 53. | 98 | 40 | 3 | 18 | 18 | 1 |
| 54. | 48 | 37.3 | 19.3 | 15.3 | 2.6 | 0 |
| 55. | 108 | 37.3 | 29.3 | 8 | 0 | 0 |
| 56. | 49 | 35.3 | 8 | 6 | 16 | 5.3 |
| 57. | 70 | 34.6 | 0 | 21 | 22 | 0 |
| 58. | 44 | 34 | 12 | 12 | 8 | 2 |
| 59. | 66 | 34 | 9.3 | 8 | 16.6 | 0 |
| 60. | 8 | 32 | 8 | 16 | 8 | 0 |
| 61. | 42 | 32 | 2.6 | 0 | 24 | 5.3 |
| 62. | 45 | 32 | 0 | 10 | 22 | 0 |
| 63. | 112 | 32 | 6 | 18 | 8 | 0 |
| 64. | 113 | 31.3 | 3.3 | 8 | 16 | 4 |
| 65. | 32 | 31 | 15* | 12 | 0 | 4 |
| 66. | 53 | 31 | 2.6 | 0 | 25.6 | 2.6 |
| 67. | 88 | 30 | 30 | 0 | 0 | 0 |
| 68. | 97 | 30 | 22 | 8 | 0 | 0 |
| 69. | 114 | 29.3 | 5.3 | 8 | 16 | 0 |
| 70. | 57 | 29 | 8 | 5 | 16 | 0 |
| 71. | 6 | 28.6 | 24.6 | 4 | 0 | 0 |
| 72. | 67 | 28 | 25 | 3 | 0 | 0 |
| 73. | 118 | 26.6 | 2.6 | 0 | 24 | 0 |
| 74. | 7 | 26 | 14 | 8 | 0 | 4 |
| 75. | 1 | 24.6 | 3.3 | 3.3 | 18 | 0 |
| 76. | 64 | 24.6 | 6 | 0 | 18.6 | 0 |
| 77. | 37 | 24 | 5.3 | 16 | 2.6 | 0 |
| 78. | 12 | 23.3 | 3.3 | 0 | 16 | 4 |
| 79. | 104 | 23 | 10 | 10 | 0 | 3 |
| 80. | 105 | 23 | 17 | 0 | 0 | 6 |
| 81. | 5 | 16 | 8 | 0 | 8 | 0 |

*median

had no training in biology, ten lacked any preparation in chemistry, and fourteen of them were without credits in physics. Forty-seven teachers out of the eighty-one had had no training in the fields of geology, astronomy, or meteorology.

Table XX will also show that fifty-nine of the eighty-one teachers in the

above group, or seventy-four per cent of them, would fail to qualify under the standards recommended by the Cooperative Committee on Science Teaching of the A. A. A. S.[4]

In connection with this, further study of Table XX discloses that a number of general science teachers have accumulated many semester hours of training in one field of science and have at the same time almost no training in other science subject-matter fields. This is in a sense unfortunate in view of the fact that the great majority of the 119 science teachers in this study--approximately seventy-six per cent of them--had been called upon to teach general science.

---

[4] Ibid.

# CHAPTER VI

## THE WORK PERFORMED BY THE BEGINNING SCIENCE TEACHERS

In this part of the inventory the novice teachers were asked to check a list of seventy duties which they might have performed as part of their jobs. They were asked to answer in each case by checking in three columns headed respectively: "I have done the following," "I have training to do the following," "I have insufficient training to do the following." No attempt was made to classify the list into the five categories such as "Profession Responsibilities," or "Classroom Techniques," etc., as in the administrators' inventory. But it was found that the teachers' responses could readily be grouped in this way for purposes of tabulation. It was also hoped that this procedure might later be used to pull into single focus the two viewpoints (administrators' and teachers') and produce a clear definition of the job of high school science teaching in Illinois.

The following reports reveal the facts of science teaching as reported carried on by the 119 beginning science teachers who participated in this study. The facts established throughout this chapter will occasionally be cited as possible bases for the administrators' opinions described earlier. They also doubtless form the bases upon which the beginning science teachers presumably formed many of their judgments (reported in Chapter VII).

In a later chapter the significance of these facts will become more apparent when teachers' and administrators' opinions will be weighed in their light. The relation of fact and opinion may lead to significant and useful conclusions for the future training programs of science teachers.

### A. COMBINATIONS OF SUBJECTS TAUGHT

That science teachers rarely devote full time to instruction in one field of science and that they are often required to teach non-science courses as part of

their job was an established fact before the inception of this study.[1] But that it was also a conspicuous element in the organization of Illinois high schools was borne out clearly in the results of the present inquiry (see Tables XXI and XXII). The novice science teachers reported a wide variety in courses taught. Also, it was found that only twenty-seven out of the entire group of 119 were teaching science courses full time. Not more than three of them were teaching all their courses within one specific field of science. The most frequent assignments reported by these teachers were: general science, followed in order by biology, physics, chemistry, and other sciences.

Table XXI

Number of Science Teachers, out of 119 Reporting, Who Have Taught in the Following Fields of Science

| Science Field | Number |
|---|---|
| General Science | 81 |
| Biology | 63 |
| Physics | 48 |
| Chemistry | 37 |
| Other Sciences* | 11 |
| Full Time in Science Teaching | 27 |
| Full Time in One Science | 3 |

*Other Sciences include earth science, science survey, physiology and astronomy.

[1] Ada E. Winans and F. C. Jean, "Educational and Professional Status in the Public Schools of Colorado," Science Education, 29-30:133-136, April, May, 1945. Also William A. E. Wright, "Subjects Taught by Science Teachers in Third Class School Districts of Pennsylvania," School Science and Mathematics, 45:45-52, January, 1945.

Table XXII

Teaching Combinations
Reported by 119 Beginning Science Teachers
In Illinois

| Teaching Assignments of Science Teachers | Bio. | Chem. | Phys. | Gen. Sci. | Other Sci. | Math. | Phys. Educ. | Ag. | Soc. Stud. | Mus. | Home Ec. | Comm. Subj. | Driver Traing. | Psych. | Inds. Arts | Admin. | Eng. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biology | 63 | 20 | 19 | 40 | 8 | 14 | 17 | 4 | 15 | 1 | 2 | 1 | 4 | 1 | 1 | 1 | 5 |
| Chemistry | 19 | 37 | 14 | 30 | 3 | 16 | 7 | 0 | 2 | 1 | 0 | 1 | 3 | 0 | 0 | 0 | 1 |
| Physics | 17 | 18 | 48 | 41 | 3 | 32 | 6 | 0 | 4 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 2 |
| General Science | 40 | 34 | 39 | 81 | 8 | 39 | 18 | 3 | 11 | 1 | 1 | 1 | 7 | 2 | 1 | 0 | 4 |

Above table is read as follows:

Out of 63 teachers of biology reporting, 20 have taught chemistry, 19 have taught physics, etc.

Out of 81 teachers of general science reporting, 39 have taught mathematics, etc.

Concerning non-science Teaching duties, a pertinent result of this study was the disclosure that 92 out of 119 had teaching to do in other than science subjects. The three "outside" subjects they reported most frequently were: mathematics, physical education, and social studies. Nearly 100 of the beginning science teachers named one or more of these subjects on their list of teaching assignments. Reference to Table XXII will show the actual scope and variety of non-science courses that some of the respondents were being required to teach. It is seen in this record that they reported teaching everything from agriculture and driver training to English, music, psychology, home economics, or even commercial subjects. It was also reported by one biology teacher that he had certain administrative duties to perform.

Nevertheless, the foregoing should be expected, since it was already noted that seventy-eight per cent of the new teachers were working in small schools with pupil enrollments below 250.[2] The fact that a school is small implies a variety of duties for all staff members; for schools enrolling fewer than 300 students can hardly justify staffing each subject area with a specialist.

It is also evident that small high schools can not fill enough classes in one particular science field to take up the full teaching time of a science teacher. If a teacher is so narrowly trained in science, therefore, that he cannot qualify to teach all the science courses offered in his school, it is more than likely that his program will be filled out with other classes.

It can hardly be expected that a science teacher could give instruction in a non-science field such as social studies, for example, with the same competence that a teacher specifically trained in the social studies would bring to the job. No more logically could the social studies teacher be expected to give a satisfactory course in physics or chemistry. However much a tribute it may be to the

---

[2]Cf. Chapter V, p. 56.

generally high caliber of science teachers that they are so often called upon to teach outside their own fields, such a state of affairs cannot provide the pupils of small high schools with the uniformly high quality of instruction to which they are entitled.

Thus both teacher and school stand to gain if the science teacher comes to his job adequately prepared to teach in all the fields of science for which courses in his school will be offered. This position derives further support from the responses of the administrators concerning the patterns of subject matter training they held to be essential to insure sound science teaching.

It will be recalled that (Chapter III, Table VIII, p. 36) the administrators' first choice was for:

> Training spread over several science subject-matter fields (such as physics, chemistry, biology, earth science, etc.), and in addition, intensive training in one field of science (such as physics or chemistry).

And in their second choice the administrators recommended:

> Sufficient training in several science subject fields such as physics, chemistry, biology, earth science, etc., so that the teacher can give instruction in more than one field of science.

There can be no question, in the light of these results, that the administrators were in effect declaring their need for teachers able to handle the full range of science offerings in their schools. Training institutions, desiring to shape science teacher programs to fit the trainees for the actual job ahead, would do well to see what that job is, seen through the eyes of high school administrators.

## B. THE DUTIES OF SCIENCE TEACHERS

Work in Classroom Techniques. Listed in Table XXIII are thirteen duties which were found associated with the area of classroom techniques. Seventy per cent of the teachers checked nine out of the thirteen, and sixty per cent of the respondents stated they had performed eleven of the thirteen duties.

Table XXIII

Per Cent of Science Teachers (out of 119) Reporting That They Have Had the Responsibility of Performing These Duties in the Area of Classroom Techniques

| | Duties in the Area of Classroom Techniques | Per Cent of Teachers Who Have Performed This Duty |
|---|---|---|
| 1. | Select and use audio and visual aids for science teaching | 91 |
| 2. | Plan laboratory experiments for the science you teach | 90 |
| 3. | Construct tests to measure the progress of your science students | 86 |
| 4. | Teach students to apply scientific principles in new situations | 83 |
| 5. | Teach students to generalize from a certain body of science content | 80 |
| 6. | Plan units of work in the science you are teaching | 77 |
| 7. | Plan field trips for science classes | 77 |
| 8. | Check on the value derived by science students from a field trip | 73 |
| 9. | Handle some unusual discipline cases | 70 |
| 10. | Teach students how to make the best use of the library facilities of your school for the science course you are teaching | 63 |
| 11. | Supervise and help students plan projects in science | 63 |
| 12. | Tutor science students for competitive and special examinations (College Boards, Westinghouse, etc.) | 12 |
| 13. | Prepare students for competitive exhibits such as Junior Academy of Science | 12 |

There is more to be found in Table XXIII, however. For example, it is interesting to note that ninety-one per cent of the teachers reported work with audio and visual aids for science teaching. Does this not mean that they have had to handle movie and slide film projectors? Were they not also expected to locate and select suitable slides, films, and other materials from various sources? The probable answer to both questions is "yes." This would seem to imply that training in audio-visual education should be a part of their job preparation.

In the same list of duties, seventy-seven per cent of the teachers reported that they had planned and conducted field trips for science classes. A nearly equal percentage (seventy-three per cent) of the teachers reported being expected to check on the value their students derived from field trips. This suggests that field trips have become a significant part of high school science courses and that teachers are expected to handle field trips and the learnings they produce as part of the science teaching job.

Sixty-three per cent of all the teachers responding were helping students select and work out science projects. An equal number of teachers held it to be part of their jobs to instruct pupils in the use of library facilities for science work. This fact becomes significant when it is also recalled: (a) that seventy-eight per cent of the teachers worked in small schools;[3] (b) that only thirty-seven per cent of the small school administrators felt that training in project guidance was essential; and (c) that this was one of the points of significant difference in administrative opinion.[4] Above all, the responses here affirm that instruction in library work and in project work is being carried on extensively as a part of science teaching in Illinois.

---

[3]See Chapter V, page 56.

[4]Cf. Table X, page 44.

Work Involving Professional Responsibilities. Beginning science teachers appear to take their professional responsibilities seriously. Table XXIV shows their reports on nine duties falling within the province of professional activity.

Table XXIV

Per Cent of Science Teachers (out of 119) Reporting That They Have Had the Responsibility of Performing These Duties in the Area of Professional Responsibilities

| Duties in the Area of Professional Responsibilities | Per Cent of Teachers Who Have Performed This Duty |
|---|---|
| 1. Keep up with the recent developments in the field of science | 94 |
| 2. Participate in professional organizations such as I.E.A., N.E.A., and science teacher organizations | 92 |
| 3. Store properly the scientific equipment and materials of your science course when these are not in use | 87 |
| 4. Estimate the amount of scientific equipment and materials needed in your science course for a year | 86 |
| 5. Take inventories of the scientific equipment and materials in your department | 85 |
| 6. Specify accurately and order the scientific equipment and materials for your science course | 85 |
| 7. Use apparatus for demonstrations which you have not used before | 77 |
| 8. Select text books, laboratory manuals, workbooks, or other teaching materials | 75 |
| 9. Repair scientific equipment | 58 |

In eight out of the nine cases, from seventy-five to ninety-four per cent of the teachers were performing these duties. The repair of scientific equipment was the only task which elicited a relatively low response (fifty-eight per cent).

It should be noted (Table XXIV) that the highest percentages recorded occurred in connection with the duties of keeping abreast of recent developments in science and of participating in educational and scientific organizations. Ninety-four per cent of the teachers reported on the former, and ninety-two per cent claimed to be active in the latter work.

Item 7 of Table XXIV brought out a significant response. Seventy-seven per cent of the teachers stated that they were required to use scientific apparatus for demonstrations which they had not used before. In the light of this reported fact, it is interesting to recall that on Table IV, page 26, a full thirty per cent of the administrators felt that training in the use of scientific apparatus was not important and should be left out of the teacher training program. Some differences of opinion can be foreseen coming out of these two sets of responses.

Nevertheless, a comparison of Tables IV and XXIV will show that a high percentage of the teachers were performing those duties for which the majority of administrators had specifically recommended training school preparation.

Work in the Area of General Education. Eight aspects of general education were incorporated in the list of duties to be checked by the beginning science teachers. The earnest and commendable efforts they were making in this area can be seen in the first three entries on Table XXV. Ninety-two per cent of the respondents were teaching students how science can be applied to the conservation of human and natural resources. Eighty-five per cent of them were teaching the relation of science to individual and community health, and eighty-one per cent of these teachers reported that they planned their instruction to meet the needs of their students. Significantly, on each of these three points, ninety-nine per cent of the administrators (Table V, page 28) felt that training for this work was either an absolute essential, or so important that it should be included in the science teacher training program if possible.

Table XXV

Per Cent of Science Teachers (out of 119) Reporting That They Have Had the Responsibility of Including in Their Science Teaching These Areas of General Education

| Duties in the Area of General Education | Per Cent of Teachers Who Have Performed This Duty |
|---|---|
| 1. Teach students how science can be applied to the conservation of natural and human resources | 92 |
| 2. Teach students how the science you are teaching contributes to the health of the individual and of the community | 85 |
| 3. Plan the science instruction to meet the needs of your students | 81 |
| 4. Use the resources of the community in your science teaching | 80 |
| 5. Emphasize where you can that certain leisure time activities require a knowledge of the science you are teaching | 76 |
| 6. Plan the science work, where possible, to contribute to the consumer knowledge of the student | 73 |
| 7. Plan the science teaching so as to combat propaganda and some commercial advertising | 71 |
| 8. Teach science so that students have a better understanding of technological society | 68 |

But the comparison of Tables V and XXV lead to less agreeable disclosures. For example, only sixty-eight per cent of the teachers reported that they were teaching science so that students would gain a better understanding of our technological society. Yet ninety-eight per cent of the administrators felt this to be such a necessary function of science teaching that it required special training.

In another case, only seventy-one per cent of the teachers planned science

teaching to combat propaganda and some forms of commercial advertising. But ninety-one per cent of the administrators had demanded specific training for the teaching of science as a method of critical inquiry (see Table V, page 28).

In a third case, that of planning science work, where possible, to contribute to consumer knowledge, ninety-three per cent of the administrators held this to be so important in a teacher's work that he should be trained for it. But only seventy-three per cent of the teachers questioned were actually including this in their instruction.

Finally, the comparison shows that in every one of the eight aspects of general education well over ninety per cent of the administrators were demanding not only that the job be done, but that the teacher should receive training in order to do it. This would imply that wherever the work in general education is not being done, it is not because the administrator of the school fails to desire it. More likely, the failure to do the job was due to the teacher's inability to perform it. And for the most part this incompetence may be attributable to his lack of training in general education during his preparation for teaching.

Understanding Boys and Girls. The need for guidance is doubtless greater during adolescence than at any other period in a young person's life. Pupils enter high schools as children and leave them on the threshold of adulthood. This fact confronts the high school teacher with a wider, far more perplexing range of psychological problems than either the elementary teacher or the college professor has to face.

But returns of the 119 beginning science teachers to this part of the study revealed that many of them were not dealing with these problems. As Table XXVI shows, the percentage of teachers reporting responsibilities in this area is conspicuously lower than that found in any other concern of high school science teaching. The responses here ranged from fourteen per cent for the lowest to

Table XXVI

Per Cent of Science Teachers (out of 119) Reporting That They Have Had the Responsibility of Performing These Duties in the Area of Understanding Boys and Girls

| Duties in the Area of Understanding Boys and Girls | Per Cent of Teachers Who Have Performed This Duty |
|---|---|
| 1. Counsel boys and girls who are in your science classes | 76 |
| 2. Handle some unusual discipline cases | 70 |
| 3. Provide for individual differences of students in your science classes | 67 |
| 4. Help the students that you teach understand their abilities so that they are willing to accept themselves | 67 |
| 5. Teach proper boy and girl relationships | 58 |
| 6. Work with the young people's group in your community | 48 |
| 7. Teach sex education | 45 |
| 8. Teach remedial work in mathematics and (or) reading so that your students can be more successful in your course | 44 |
| 9. Make out case studies of some of your students | 14 |

seventy-six per cent for the highest number of teachers reporting work in any one category out of nine listed.

The duty of counseling boys and girls in science classes was the one which elicited the highest percentage (seventy-six per cent) of response. A glance at Item 6 of Table VI, page 31, shows that ninety per cent of the administrators had favored training-school preparation in youth-counseling techniques. The least reported activity (fourteen per cent response), that of making out case studies

of certain students, was held to be important by well over half of the administrators. But perhaps the rather lukewarm concern of administrators for case study work is what has been evidenced in the small number of teachers who reported carrying it on.

But in two instances a striking discrepancy arises between the demands of administrators and what the teachers were actually doing. Table VI will show that one hundred per cent of the administrators demanded competence in providing for individual differences in the classroom. In fact, eighty-one per cent of them felt that training for this ability should be a minimum essential in the science teacher training program. Yet, only sixty-seven per cent of the teachers (Table XXVI) replied that they were doing this part of their job.

Exactly the same figures resulted from the question of helping students understand their abilities so that they might willingly come to accept themselves. Again, one hundred per cent of the administrators desired some training of teachers for the ability to help students in this way. And eighty-one per cent of the administrators felt the work so important that training for it should be a minimum essential in science teacher preparation. But here, too, only sixty-seven per cent of the teachers were handling this responsibility.[5]

At least in the two cases cited above, the percentage of teachers failing to discharge their responsibility for dealing with adolescent pupils cannot be charged to the indifference of their supervisors. On the contrary, it points up a case where many high school directors are not getting one of the things they want most in their science teachers.

If a teacher lacks training in adolescent psychology, he may fail even to recognize some of the problems which are affecting his students. Or, if he senses the existence of problems, he may shy away from efforts to deal with them out of a feeling of inadequacy and of not knowing what to do.

---

[5]See Tables VI and XXVI.

Lack of training rather than administrative indifference is apparently the prime cause of the weak responses in the area of understanding boys and girls. If this is the case, the continuation of the deficiency could be prevented to a great extent in the teacher training schools. One remedy would call for inclusion of training in adolescent and social psychology in the curriculum of all prospective high school teachers, including, of course, science teachers.

Other Responsibilities. The activities of the beginning science teachers, recorded in Table XXVII, may be seen to fall roughly into three types: (1) school and community social activities; (2) work with others on problems of school life; and (3) routine and technical duties.

In the social life of school and community the teachers of this study seem to have taken an active part. The high percentage figures in the responses to Items 1, 3, 4, and 9 may be noted in Table XXVII. Science teachers have planned and chaperoned school parties and taken part in the social activities of the community too. In over half of the cases there appeared to be genuine interaction between schools and communities on the social plane, as seen in the reports of teachers who had "open house" at their schools. The value of a teacher's social contribution to his school has been widely recognized by the administrators too. Table VII (page 33) disclosed that ninety-seven per cent of them favored training school preparation of prospective science teachers for assuming social and civic responsibilities as part of their professional work.

The question of the amount of time a teacher should be expected to give to the extra-curricular part of his work is one that may need consideration in the light of the teachers' opinions to be taken up in the next section of this study.

In the responses numbered 2, 5, 8, and 10 in Table XXVII, the beginning science teachers reported their work with others in solving problems of the school. Eighty-two per cent of them were working with other teachers in planning

Table XXVII

Per Cent of Science Teachers (out of 119) Reporting That They Have Had the Responsibility of Performing These Additional Duties in Their Teaching Assignments

| | Other Duties Assigned to Beginning Science Teachers | Per Cent of Teachers Who Have Performed This Duty |
|---|---|---|
| 1. | Chaperon school parties | 97 |
| 2. | Work with other teachers in solving problems of the school | 92 |
| 3. | Plan school parties | 89 |
| 4. | Take part in social activities of the community | 86 |
| 5. | Work with other teachers in planning various activities of the school program other than curricular ones | 82 |
| 6. | Fill out various forms and records for the school office | 80 |
| 7. | Administer or help supervise the giving of standardized tests | 63 |
| 8. | Work with other teachers in your school in the study of your curriculum and possible revision of it | 59 |
| 9. | Prepare for an open house at your school | 57 |
| 10. | Direct activities of home room or group of advisees | 52 |
| 11. | Interpret various diagnostic instruments that your school uses (I.Q. tests, aptitude tests, interest tests, etc.) | 43 |

extra-curricular school activities. Nearly sixty per cent reported some work in the study, planning, and development of the school curriculum. And over half of them were in charge of home rooms and directing the activities of advisees. The administrators seem to be well justified in their demand for training in

cooperative group work on the basis of these facts. It will also be recalled that ninety-six per cent of the administrators had called for training school grounding in curriculum development (see Table VII, page 33). The high demand for curriculum work and the comparatively low percentage of teachers engaged in it suggests that lack of training has prevented many teachers from taking part in work where their services were needed.

The third phase of school activities carried on by these teachers is seen in Items 6, 7, and 11 of Table XXVII. The great majority of them, as might be expected, were required to fill out various forms and records for the school office. Sixty-three per cent of them were administering or supervising the giving of standardized tests. But only forty-three per cent of the beginning science teachers reported work in interpreting the various diagnostic instruments used in their schools, such as I.Q., aptitude, and interest tests. That teachers would be given more responsibility for testing and diagnostic work if they could handle it competently is evident in the responses of their supervisors. Ninety-four per cent of the administrators felt that teachers should be trained in testing and diagnostic work before they come to their jobs.[6]

## C. SUMMARY

In this chapter we have studied the factual reports of the beginning science teachers of the work they were doing on their jobs. After a report on the subjects they were teaching, their responses were traced through the five areas of teaching activity for which the administrators had been asked to consider training requirements. In many cases the administrators' responses were reviewed in order to give clearer meaning to the facts reported. Frequently, where administrators had most strongly asserted their need for the competent handling of a particular phase of teaching, the facts indicated that the job was not always being done.

---

[6]See Table VII.

A tentative explanation was offered for the discrepancy between the teachers' work and the work expected of them by their administrators. It was that the teachers were not adequately prepared to carry on these responsibilities. The following chapter, which reports on the study of the teachers' opinions of their jobs and of themselves as teachers, will bring out the full implications of the facts just reviewed.

# CHAPTER VII

## THE OPINIONS OF BEGINNING SCIENCE TEACHERS ABOUT THEIR TRAINING, ABOUT THEIR JOBS, AND OF THEMSELVES AS TEACHERS

For gaining a balanced perspective in this study of science teaching in Illinois, the judgment of the beginning teachers themselves was considered essential. They were asked to give their views on the nature of their work and its demands. They were requested to evaluate their own success or lack of it as teachers new in the field, expecially in the light of the formal training they had received.

In this chapter the kinds of value judgments sought frequently varied with the type of questions being considered. For example, some opinions were to be related specifically to aspects of formal programs in teacher training institutions. Other parts of the inventory asked for judgments about the job of teaching in the field and the training to be gained "on the job." Some questions merely required yes or no responses, whereas others provided for a degree of uncertainty in the replies. Because of these differences in approach to various topics and of the details of opinion sought, the contents of each table will require rather careful study.

### A. THE TEACHERS JUDGE THEIR SUBJECT-MATTER PREPARATION

The findings reported in Table XXVIII represent the basis of the present discussion. The teachers were asked to give yes, uncertain, or negative answers to nine questions. The questions will be seen to constitute recommendations for the adjustment of training school programs. In terms of their own experience the teachers were thus requested to construct a type of program which would have prepared them for the actual job of science teaching as they perceived it.

Table XXVIII

Opinions of Beginning Science Teachers

About Their Subject-Matter Preparation

| Questions About the Subject-Matter Preparation of Science Teachers | Per Cent of Teachers Who Responded | | |
|---|---|---|---|
| | Yes | Uncertain | No |
| 1. In terms of your personal experience in teaching do you think the areas of specialization in science for a teacher should be broadened so that the teacher may specialize: | | | |
| a) In physical science rather than physics, chemistry, geology, etc.? | 63 | 24 | 11 |
| b) In biological science rather than botany, zoology, physiology, etc.? | 74 | 12 | 14 |
| c) In science rather than the various branches such as chemistry, botany, physics, biology, zoology, physical science, etc.? | 38 | 27 | 35 |
| 2. In terms of your experience, was your training in science too broad, i.e., would you be better prepared to do your job if you had specialized in one branch of science such as chemistry, botany, zoology, etc.? | 2 | 6 | 91 |
| 3. The curriculum of the present science fields was constructed largely as background foundation for the professions of engineering, medicine, and research in special fields. In terms of your experience, should the needs of teachers have recognition equal to that now awarded other professional groups in the construction of future science curricula on the college level? | 85 | 12 | 3 |
| 4. In terms of your experience, should the subject matter areas give more attention to the effects of scientific achievements on society? | 75 | 20 | 5 |
| 5. In terms of your experience, do you think the subject matter courses taken by prospective teachers should give concrete exemplifications of the theories and philosophies of science education? | 66 | 20 | 11 |
| 6. Should the converse of the above question obtain? That is, should the courses in the subject-matter courses be kept distinct and apart from the educational theories and philosophies? | 10 | 12 | 76 |

Table XXVIII (Continued)

| Questions About the Subject-Matter Preparation of Science Teachers | Per Cent of Teachers Who Responded | | |
|---|---|---|---|
| | Yes | Uncertain | No |
| 7. In terms of your experience, were the science courses that you took on the college level broad enough in scope, i.e., did they "tie-in" with other courses of science, and with non-science branches of knowledge? | 62 | 12 | 26 |
| 8. In terms of your experience, should more attention be given to "out of school" experiences, such as field trips, and less emphasis be placed on technical laboratory experiences? | 40 | 31 | 18 |
| 9. Do your experiences support the opinion that the following values result from the present methods of specialization in teacher education in science: | | | |
| a) Understanding the manner in which things are found out, such as scientific method, including conditions that must be fulfilled before a conclusion is substantiated, bases of scientific authority, meaning of theory and fact? | 72 | 18 | 8 |
| b) Practice in use of scientific methods in research? | 65 | 11 | 12 |
| c) Discipline, such as habits of accuracy, open-mindedness, inquisitiveness, etc.? | 62 | 23 | 14 |
| d) Knowledge of the inter-relatedness of the sciences? | 57 | 23 | 17 |
| e) Development of lifelong interests and hobbies? | 56 | 20 | 21 |
| f) Practice in interpreting propaganda? | 55 | 22 | 22 |

The first two questions explored the issues of breadth and of specialization in science subject-matter training. The teachers' answers indicated that they would prefer specialization in one broad field of science, such as physical science or biological science, rather than in one particular area within that broader field. They were found to react against a generalized training in science without specialization in one clearly defined field. They were nearly unanimous (ninety-one per cent) in their rejection of narrow specialization within one branch of science, such as chemistry, botany, or zoology.

In their collective judgments concerning science subject-matter preparation,

the novice teachers are found to be in substantial agreement with the administrators in the state of Illinois. A glance back to Table VIII, on page 36, shows the administrators' first choice for the subject-matter training program as:

> Training spread over several science subject matter fields, such as physics, chemistry, biology, earth sciences, etc., and in addition, intensive training in one field of science.

In their second choice the administrators also called for breadth in training, but at the same time required sufficient depth of preparation to permit teaching in more than one field of science.

It will be recalled from Chapter V that the majority of the beginning science teachers in this study had received training which was both narrow in scope and limited in extent. Very few of them had had preparation adequate to meet the standards set down by the Cooperative Committee on Science Teaching of the A.A.A.S., and some of them fall short of state standards for sufficient credits in major and minor science subjects.

With the concurrence of opinions just noted and the pertinent facts at hand, it would seem that there is now some basis for later recommendations on the framework of subject-matter organization in future science teacher training programs.

Question 3 is admittedly a leading question in that it states that courses in science were set up for purposes other than teacher preparation. Nonetheless, it is of interest that the vast majority of science teachers questioned apparently accepted the judgment that science courses in college were primarily designed to prepare engineers, medical students, or specialized research workers. Eighty-five per cent of them agreed that college science curricula should be constructed to serve equally well the needs of the teaching profession.

Questions 4 and 7 brought forth recommendations for a closer integration of subject-matter areas within various fields of science and for a closer relation of science subjects with other non-scientific branches of knowledge.

In response to Questions 5 and 6 the teachers seemed to call for the incorporation of theories and philosophies of science education into their subject-matter courses. Their responses lead to the conclusion that the beginning teachers favor the professionalization of subject-matter courses as is commonly done at many colleges devoted primarily to teacher training.

There seemed to be some confusion among the teachers in their answers to Question 8. Twelve per cent of them failed to answer it at all, and nearly a third of them were undecided. Nevertheless, forty per cent of the individuals interpreted the question, in terms of their own experience, to mean that they would favor the inclusion of more non-technical, non-laboratory aspects of science learnings in teacher training programs.

Six elements of value presumably resulting from scientific training were judged in replying to Question 9. Four of the six (a, b, c, and f) dealt with the many uses for scientific method with its reliance upon critical thought and inquiry. From fifty-seven to seventy-two per cent of the teachers felt they had gained some of these values from their training in science education. But some teachers were uncertain about this (eighteen to twenty-three per cent), and from eight to seventeen per cent of their number asserted that they had derived no such values.

These results gain significance in a review of the administrators' opinion of the value of scientific method. Fifty-four per cent of the administrators had subscribed to the inclusion of training to understand the nature of science as a method of critical inquiry as a minimum essential in science teacher preparation. Another thirty-seven per cent had held it to be important and to be included if possible in teacher training.[1]

---

[1] See Table V, page 28.

It can be concluded from these results, then, that the nature of scientific thought and inquiry has been held by both teachers and supervisors to be an important value in science education. It can also be concluded that both of these groups expect and desire this value to be one of the fundamental outcomes of training for science teaching.

Parts d and e of Question 9 inquired about two more outcomes supposedly resulting from scientific training. In Part d, to the question of whether they had gained any knowledge of the inter-relatedness of the sciences, the number of uncertain and no replies would seem to be related to the teachers' earlier recommendation for more integrated science training. Yet over fifty per cent felt that this objective had been realized in their own training. In Part e, slightly more than half of the teachers felt their experiences in training had led to the development of lifelong interests and hobbies. About the same number felt that their training had helped them gain practice in combatting propaganda.

Some Comments Made by the Teachers on Their Subject-Matter Preparation. The responding teachers showed much concern over the question of subject-matter preparation for science teaching. The write-in comments which appeared in this section of the inventory reveal a readiness on the part of the teachers to state frankly their feelings and to admit their inadequacies of preparation for the job they were trying to do. The following statements were taken directly from the inventories:

(1) Subjects required in science for a minor are inadequate for preparation to teach the subject. [Minor]

(2) Too much time is spent on subject material that is never used in teaching. Science should be taught as it is taught in high school.

(3) My subject-matter courses were taken two and three years before I began teaching. As my field was not science, I had no courses in science as an upper classman.

(4) There often is not a concrete tie-up between classroom material and laboratory work.

(5) Some courses are much too technical to be of use in teaching on the secondary level. Too many physical education majors have science minors, and are teaching science along with physical education. Their science training is extremely inadequate.

(6) I do not feel a college minor in chemistry with a little botany, health, microbiology, and household physics is sufficient background for teaching as broad a subject as general science.

## B. THE TEACHERS JUDGE THEIR PROFESSIONAL EDUCATION

Their Practice Teaching. Important in the training of any teacher is the experience he gains in the actual practice of teaching. For this reason the inventory called for the opinions of the beginning science teachers about their own practice teaching experiences and their preferences concerning the future development of student teaching programs. Table XXIX describes their responses to these questions. It is evident from these data that most of the beginning science teachers did not experience the responsibility of a full teaching load during their student teaching. Nor could it be determined from their replies that they had dealt with pupils representing a full representative range of individual differences in ability. On the other hand, the fact that such a small minority of the teachers felt they had been considered inferior by their pupils suggests that in general the practice classroom situation had not differed radically in atmosphere from that in which the pupils were accustomed to work.

In their answers to questions concerning the development of student teaching programs (Table XXIX) the beginning teachers tend strongly to the preference that the practice classroom situation should be as nearly like the situation to be met on the job as possible. But less than half of the new teachers queried felt certain that a student teacher should carry a full teaching load or be burdened with the full responsibility for his classes during his practice period. Some further observations on practice teaching are here presented directly as they appeared on the returned inventories:

Table XXIX

Opinions of Beginning Science Teachers on Their Own Practice Teaching Experiences and on Three Proposals for Future Student Teaching

| | Per Cent of Teachers Who Responded: | |
|---|---|---|
| | Yes | No |
| A. Was your student teaching program designed: | | |
| (1) to permit you to carry a complete teaching load? | 28 | 71 |
| (2) so that your students were average or above in ability? | 42 | 58 |
| (3) so that you were recognized by the students as an inferior substitute whom they must endure for a certain number of class periods? | 15 | 84 |

| | Per Cent of Teachers Who Responded: | | |
|---|---|---|---|
| | Yes | Uncertain | No |
| B. Do you feel that a student teaching program would give a better preparation for teaching if: | | | |
| (1) it permitted the student teacher to carry a complete teaching load? | 55 | 22 | 22 |
| (2) the students to be taught by the student teacher range from low to high ability so that more problems of adjustment will become apparent? | 90 | 8 | 2 |
| (3) the student teachers were permitted to take over full responsibility as a regular teacher with little or no supervision? | 36 | 15 | 49 |

(1) Biology was my minor. I taught it without having any experience in handling a laboratory situation. Undergraduates should have experience in teaching not only their major but also the minor subject.

(2) Practice teaching does not prepare one for actual teaching situations. More emphasis should be put on meeting the needs of students with the science program.

(3) Too much emphasis is put on subject matter and not enough on how to present it to a class that you teach. In taking my practice teaching I had to teach the way the "critic" wanted me to. In other words, I had to teach for a grade.

Comments such as those recorded above seem to offer useful suggestions for the construction of improved student teaching programs. For a more positive expression of opinion, attention is called to the results seen in Table XXX. It will also be seen that the overwhelming majority of the 119 beginning science teachers in this study were in complete agreement with their supervisors as to the most effective method for the direction of student teaching. The first choice of the administrators, as seen in Table IX, on page 41, was for student teaching carried on: "In an ordinary teaching situation in the public schools, under the direction of an expert teacher." This was the choice of eighty-seven per cent of the beginning science teachers. They also appeared to attach a degree of

Table XXX

Opinions of Beginning Science Teachers on the Importance of Three Methods of Directed Student Teaching

| Methods of Directed Student Teaching | Per Cent of Teachers Who Rate This Method as Most Effective |
|---|---|
| 1. Under special training teachers in training schools | 5 |
| 2. In an ordinary teaching situation in public schools under the direction of an expert teacher | 87 |
| 3. In an experimental school where recent theories of education are applied in concrete situations | 7 |

importance to an opportunity to observe competent teachers at work. This is evident in their replies to the question, "In terms of your experience, to what extent should attention be given to (student) teacher observation of competent teachers?" Seventy-four per cent of the replies asserted that this was essential in the training program; nineteen per cent stated that it was important but could be acquired on the job. Only seven per cent of the replies indicated that observation was unimportant and should be supplanted by other training.

Preparation for Understanding Boys and Girls. Questions in this area of teacher training brought forth strongly positive responses from the beginning science teachers. From eighty-one to eighty-nine per cent of the teachers rated all five aspects of the study of boys and girls in the questionnaire as essential to adequate teacher training (see Table XXXI). Eighty-nine per cent of the young teachers felt that some knowledge of the problems of adolescence was indispensable to the training of teachers. Barely one teacher in ten felt that such knowledge could be acquired on the job. The second question noted in Table XXXI deals with another aspect of the same topic and the resulting answers are substantially in the same proportions. A brief glance back to the administrators' replies in this area reveals their one hundred per cent unanimity on the importance to teachers of "knowledge about the physical and mental development of boys and girls of adolescent age."[2]

Nearly nine out of ten beginning science teachers reflected their concern with problems of motivation and pedagogical method in their answers to the third question on Table XXXI. Eighty-nine per cent of them considered that this area of training was to be included as an essential part of professional preparation.

The full import of the teachers' response to the question on the importance

---

[2]Table VI, page 31.

Table XXXI

Opinions of Beginning Science Teachers About the Importance of Some Characteristics of Boys and Girls in the Teacher Training Program

| Questions About Training for an Understanding of Some Characteristics of Boys and Girls | Per Cent of Teachers Who Rate the Question: Essential in Teacher Training Programs | Important But Can Be Learned on the Job | Should Be Left Out to Give Time for Other Training |
|---|---|---|---|
| In terms of your experience to what extent should attention be given in the study of boys and girls in relation to: | | | |
| 1. The problems boys and girls are facing or will have to face as they mature? | 89 | 9 | 1 |
| 2. The personal characteristics (understandings, attitudes, skills, etc.) they will need if these problems are to be met adequately? | 85 | 15 | 0 |
| 3. The problem of motivation and the methodologies suitable in achieving the goals of modern education? | 89 | 9 | 1 |
| 4. The nature of individual differences? | 85 | 15 | 0 |
| 5. The interests and needs of boys and girls at different grade levels? | 81 | 19 | 0 |

of studying the nature of individual differences comes with a brief review of results previously noted. For example, only sixty-seven per cent of the teachers had reported they were providing for individual differences among the students in their science classes (Table XXVI). That there was a demand for such provision had been established in the administrators' responses.[3] One hundred per cent of the high school supervisors had called for the inclusion of study on the nature of

[3]Table VI, page 31.

individual differences on the training program, and eighty-one per cent of them had rated it a minimum essential. Therefore, the eighty-five per cent response of the beginning teachers that this training should be an essential part of the formal preparation probably reveals their general recognition of both the demand and their need for training to meet this responsibility. It also reveals that many of the teachers not reporting work in this area may have failed to do so because lack of training left them unable to cope with this problem.

The last question in Table XXXI inquired whether a study of the interests and needs of boys and girls at different grade levels was essential to a teacher's pre-job training. Eighty-one per cent of the teachers asserted that it was essential in a teacher training program, while nineteen per cent of them felt this knowledge was important but could be learned on the job. Seventy per cent of the administrators had considered this a minimum essential element in teacher preparation and twenty-nine per cent of them had stated it was important and should be included in the program if possible.[4]

It would seem from their responses that most administrators do not feel this aspect of training should be left to be learned on the job. There is an obvious relation between the question of pupil needs and interests and the problems of motivation and methods of teaching. This relation may itself point to the necessity of providing prospective teachers with fundamental learnings in educational psychology before they go into the field.

Some Comments from the Beginning Science Teachers about Their Professional Training. In their write-ins the teachers commented frankly on the training they had received. It would seem that they held in question nearly every aspect of present programs of teacher training. Some of the following comments (directly

---

[4]See Table VI, page 31.

transcribed from the inventories) point up verbally what the statistical data in this study have already implied.

Lack of Correlation in Studies:

(1) Frankly, I saw very little inter-relationship until I took a summer in the Curriculum Workshop where we actually had to work out these relationships. I certainly didn't get it in science class.

(2) First of all, the specialized courses in science do not show the teacher how to teach the course in question. Second, the educational theories courses are always concerned with the ideal classroom which is altogether different from what the teacher finds on the job.

(3) The present day education courses are too clearly and distantly separated from the real situations that science teachers encounter.

(4) Courses usually give facts and more facts. What we need is workable material that will be of interest to the bulk of the children. We must get more practical and less theoretical.

(5) One great fault I find in my own daily practice, I teach the students the high and mighty scientific method and then find myself violating the same in my own class room procedures.

Other Comments on Teacher Preparation:

(1) Every school does not have adequate equipment for science.

(2) In college we work with the best of equipment; in the field of teaching the situation is usually the reverse.

(3) There is not enough training in visual aids, and for sponsoring science clubs, exhibits, etc. in the community. It would be better to have practice teaching under supervision in a more real setting; that is, in a community such as the one we are likely to teach in.

(4) No provision is made for training the teacher for his teaching duties outside the classroom, i.e., certificates, records, home room, guidance, discipline, etc.

(5) There isn't any subject matter for teacher preparation in universities. Too much theory and too few concrete examples. We should have standard courses for teacher training similar to the fields of law and medicine.

The Teachers View Their Education for Life in Contemporary Society. To round out the picture of their preparation as science teachers, the inquiry was directed into one more phase of the training these people had received. This had to do with the sum total of their education as preparation for life as adults in the

world of today. Fifteen questions, each dealing with some aspect of knowledge necessary for competent participation in our society, were presented to the teachers. It was felt that these questions would bring out not only their general conception of education and its scale of values, but also their views about how much this education could be gained in and through programs of teacher training. In a sense, these young teachers may be seen to express their philosophy of life in the following record of their replies. They were asked to answer each question as to whether the particular knowledge should be gained as an essential in the teacher training program, whether it could be learned on the job, or whether such learning should be left out of a program to leave room for other training.

In all fairness it should be kept in mind that no teacher training program could or should be expected to provide all the preparation an individual must have in order to live intelligently in present day society. But it would be well to see what particular elements in such preparation might become desirable or appropriate features of a training program for science teachers.

In regard to each question noted in Table XXXII the following frame of reference from which to answer was given:

> In looking back on your education for preparing to teach and appraising it in terms of your experience to date, to what extent should emphasis be placed on study and research related to:

Reading through the fifteen questions reveals that they fall roughly into four areas of knowledge and information: (1) about the nature of man, his growth, his behavior, and his needs; (2) about the economic factors affecting man; (3) about the political and sociological problems of our society; and (4) about philosophical and intellectual concerns of modern living.

The teachers seem to consider knowledge about man himself the most essential and important object of study. In every case of the first four questions in Table XXXII, over ninety per cent of the teachers held this knowledge to be

Table XXXII

Beginning Science Teachers Estimate the Contribution Which Training Programs Might Make to Education as Preparation for Life in Present Day Society

| Questions About Some Aspects of Education as Preparation for Life in Present Day Society | Per Cent of Teachers Who Rate the Question: Essential in Teacher Training Programs | Important But Can Be Learned on the Job | Should Be Left Out to Give Time for Other Training |
|---|---|---|---|
| In looking back on your education for preparing to teach and appraising it in terms of your experience to date, to what extent should emphasis be placed on study and research related to: | | | |
| 1. The growth and development of the human being from prenatal stages to maturity? | 94 | 4 | 1 |
| 2. Public health, public health agencies, communicable diseases (including veneral), their extent, ways of transmission, and methods of control? | 93 | 6 | 1 |
| 3. Mental health, analysis of factors contributing to mental disorders, and development of mental hygiene? | 90 | 8 | 2 |
| 4. Matters concerning sex adjustments, problems of sex relationships, marriage, physiology of sex, and emotional orientation in matters of sex? | 90 | 4 | 5 |
| 5. Conservation and the use of natural resources including forests, soil, minerals, water, and others? | 89 | 9 | 2 |
| 6. Development of a coherent picture of the world and the ability to adjust the conflicts in thinking that have arisen from scientific interpretations of the nature of the world; for example, concepts of time, space, evolution, the man's position among living things? | 78 | 17 | 4 |

Table XXXII (Continued)

| | Essential in Teacher Training Programs | Important But Can Be Learned on the Job | Should Be Left Out to Give Time for Other Training |
|---|---|---|---|
| 7. Propaganda analysis, whether the propaganda be that of commercial advertising, of pressure groups, or even of formalized education? | 78 | 19 | 2 |
| 8. Matters relating to food requirements and the study of the metabolic changes in man? | 77 | 17 | 5 |
| 9. Practice in using the scientific method in solving or in dealing with practical problems and questions such as problems of consumer action, transportation, government control of resources, etc.? | 74 | 24 | 2 |
| 10. Effects of science in the development of the modern industrial power age, and science's responsibility in securing individual and economic adjustment in such a dynamic society? | 74 | 22 | 4 |
| 11. Development of how knowledge of scientific facts and principles has contributed to more intelligent consumption of goods and services? | 72 | 20 | 8 |
| 12. The nature of man, his behavior and his various cultures? | 71 | 19 | 10 |
| 13. Development of such principles of ethics as are consistent with the findings of science and are workable in modern technological society? | 63 | 23 | 13 |
| 14. Research itself, and the understanding of the conditions that must be fulfilled before generalizations may be made? | 60 | 26 | 14 |
| 15. Science in controversial issues such as political platforms, labor questions and government control of resources? | 55 | 30 | 15 |

essential in a teacher training program. These questions dealt with the study of human growth and development, the nature and problems of sexual behavior, health and the prevention of disease, elements of clinical and social psychology, and essentials of social and cultural anthropology. From replies affirming these learnings as essential in a teacher training program, two inferences may be drawn. First of all, it can be inferred that the vast majority of teachers questioned felt that well-grounded knowledge about man's behavior and about human relations is absolutely indispensable for competent participation in the complex society of today. Secondly, it seems that the teachers felt that teacher training programs should provide some foundation in this essential knowledge rather than leave to chance that it be acquired elsewhere.

In the second area of preparation for adult living the teachers were asked four questions (Items 5, 9, 10, and 11 in Table XXXII). These concerned knowledge about the economic relations among men in the production, distribution, and consumption of goods and services. The strongest response in this area came to the question (Item 5) of the conservation and use of natural resources, such as forests, soil, minerals, water, and so forth. Eighty-nine per cent of the teachers felt that study of conservation problems should be essential in the teacher training program. Although nearly a fourth of the teachers thought that practice in using the scientific method to solve practical economic problems could be learned on the job, seventy-four per cent of them felt that such practice should be gained as an essential feature of teacher-training.

It has become almost a platitude that science has had an overwhelming impact upon almost every phase of life in the present industrial era. In its effects upon individuals and upon whole ways of life, science is seen to reach beyond the textbook and the laboratory. A more recent conviction arising out of this awareness of the role of science has been that science has a responsibility for the

well-being of the society which it has so largely shaped. The awareness and acceptance of this responsibility is implicit in the replies of ninety-six per cent of the beginning science teachers. Seventy-four per cent of the respondents felt that training for an understanding of the responsibility of science was essential in the program of science teacher preparation.

Where such an understanding could be gained opens up the question of the relationship between scientific studies and non-science courses during teacher training. For it becomes clear that the disciplines of sociology and psychology, economics, and even political science are the frames of reference from which the role of science must be viewed if its responsibilities are to be recognized. It will be recalled from an earlier section of this chapter that one of the sharpest criticisms made by the beginning science teachers of the training they had received was its lack of relatedness among subjects, especially among science and non-science subjects. If part of science teaching is to make clear to young people the cause-effect relationship between the science courses they are studying and the complicated world in which they live, there is here a strong argument for the revision of teacher training programs toward closer integration between science and non-science subjects.[5]

Another phase of training for science teaching impressed seventy-two per cent of the respondents as essential. This was the teaching of how scientific principles contribute to the more intelligent consumption of goods and services (Table XXXII). Sound teaching in this area would require some knowledge of practical economics and various economic systems and theories. Thus it may be seen that if such teaching is a desirable part of high school science courses, there is a

---

[5]Ninety-eight per cent of the administrators called for the teaching of "the effects of science and technological development upon present day society," it will be recalled. (See Table V, page 28, for percentages.)

further argument for correlation of science curricula with non-science subjects during a teacher's training.

Questions numbered 7 and 15 in Table XXXII show the responses of teachers concerning the relationship of science to the social and political phases of contemporary life. Seventy-eight per cent of the respondents see as an essential of teacher training the importance of the discipline of scientific inquiry as an effective approach to the problem of propaganda analysis.

On the question of science as a factor in some controversial issues such as political platforms, labor questions, government control of resources, etc., and as a method to be used in studying them, the respondents displayed less conviction. Only fifty-five per cent of them felt that training for this understanding was essential in teacher preparation. Thirty per cent felt it was important but could be learned on the job, while fifteen per cent felt that training for meeting controversial issues was not appropriate to teacher preparation. It is known that there is prevalent among members of the teaching profession a strong reluctance to bring up in the classroom controversial issues of any kind. The responses to this last question may be an expression of that reluctance. However, to explain, justify, or condemn such attitudes is not the province of the present discussion. Nevertheless, since young people will inevitably face and deal with important controversial matters in their later lives, it can be argued that their education should prepare them in some way to do so. And there can be little disagreement with the contention that the methods of science, founded upon objectivity and critical thinking, can offer just such preparation.

The beginning science teachers in this study seemed to consider definite philosophic and intellectual guidance as a vital part of their training and preparation for living and teaching. Their responses to Questions 6, 13, and 14 as reported in Table XXXII will attest to this. Seventy-eight per cent of them held

the following to be essential in the teacher training program:

> Development of a coherent picture of the world and the ability to adjust the conflicts in thinking that have arisen from scientific interpretations of the nature of the world; for example, concepts of time, space, evolution, the earth's position among living things.

Sixty-three per cent of them felt that "development of such principles of ethics as are consistent with the findings of science and are workable in modern technological society" was essential in a science teacher's training program. The nature of inquiry as the basis for the establishment of generalizations was felt to be an essential study in training programs by sixty per cent of the teachers (question 14).

These teachers seem thus to share in the growing awareness that, in a world of convulsive change and shift, one of man's greatest tasks is that of maintaining his own intellectual and spiritual identity. For anyone to accomplish such a task he must have developed an adequate perception of his world and of his relation to it. He must also find a code by which to guide his actions and his efforts to get along with others. It is not expected that any one agency, be it home, church, school, or adult experience could provide the sum total of all the knowledge and understanding necessary to a workable philosophy of life. But that the training institution is expected to make its own unique contribution to this end is apparent in the replies of a clear majority of the young teachers who took part in this study.

The foregoing discussion completes the present examination of the appraisals made by 119 respondents of their preparation for life as high school teachers of science. In the following section these same individuals will be seen as judges and critics of their schools and of themselves. Many of the attitudes expressed by these young teachers in evaluating training programs can be seen as reactions to the realities of the job as they have come to perceive them.

## C. HOW BEGINNING SCIENCE TEACHERS JUDGED THEIR SCHOOLS AND THEIR SUCCESS IN MEETING THE DEMANDS OF THEIR WORK

The findings in this part of the study may be seen to bring up other questions of importance to the science teacher than merely those of formal training. These are the economic and social factors in the life of a high school teacher. The questions of economic security, of advancement on the job, of satisfactory earnings, and of a well-adjusted social life are not entirely decided by the degree of competence a teacher displays in his work. Nor are they determined altogether by the administrators of the school or by the interpersonal relations of a teacher and his colleagues on the school staff. The relations between a school and the community it serves have much to do with the character of the job. This will be seen clearly in many of the following responses which the assurance of anonymity made possible.

The Teachers Appraise Their Schools. Table XXXIII summarizes the reactions of the beginning science teachers to six questions concerning their schools.

Table XXXIII

Opinions of Beginning Science Teachers About Their Schools

| Questions Asked Beginning Science Teachers About Their Schools | Per Cent of Teachers Who Responded: Yes | Uncertain | No |
|---|---|---|---|
| 1. Are you given sufficient voice about school plans and policies that relate to your own work? | 65 | 4 | 30 |
| 2. Are you able to use the teaching methods which you believe to be effective? | 64 | 10 | 26 |
| 3. Are teachers treated by local people as members of the community? | 65 | 9 | 26 |
| 4. Do you have sufficient time to prepare for your teaching? | 57 | 6 | 37 |
| 5. In your school system do promotions go to staff members who deserve them? | 30 | 38 | 25 |
| 6. Does your present position offer favorable prospects for professional advancement? | 29 | 24 | 47 |

Although nearly two-thirds of the teachers felt they had been given enough voice in school policy and planning related to their own work, a full thirty per cent of them reported they got no such recognition. It would also seem that teachers are not always allowed to exercise their own judgment in the classroom. Twenty-six per cent reported that they had not been able to use the teaching methods they considered most effective. Ten per cent were undecided, and sixty-four per cent of them felt they had been free to choose their methods.

The way a teacher feels he is treated by the local people in his community can have a strong effect on the way he goes about his work, on his personal feeling of satisfaction and well-being. If he is made to feel a thing apart, an alien element in the stream of life going on about him, or if he is made to feel that his every action is being judged--down to the last puff on a cigarette--he may decide not only to leave his present job, but even the teaching profession. In a time when more teachers are needed and when well-trained teachers are at a premium, it is a great public loss when teachers leave their work in search of happier and more satisfying ways to earn a living. That conditions leading to such deplorable results do in fact obtain all too frequently is seen in the negative answers to Question 3, as reported in Table XXXIII. Twenty-six per cent of the beginning science teachers in this study reported that they were <u>not</u> treated as members of the community by the local people. Another ten per cent were dubious about how well they had been accepted. The import of these results would seem to outweigh the sixty-four per cent of teachers who did feel accepted, at least in terms of the future members of this group who may eventually give up teaching.

Question 4 of Table XXXIII asks about the amount of time teachers can allot to daily classroom preparation. The fact that only fifty-seven per cent of the respondents felt they did have sufficient time may imply two possible explanations for the replies of the other forty-three per cent. Either a great many teachers

do not know how to plan and organize their time or they have so many things to do that little or no time is left for classwork preparation. If we turn back to the teachers' reports on other than classroom duties (Table XXVII, on page 87), we may gain some insight on this question. There is implicit in this record a number of time-consuming activities, which many of the teachers apparently found unavoidable. Committee meetings of all kinds, advisory work, school social activities, and a variety of routine duties must inevitably have taken up much of what little remains of a teacher's time after all his hours in the classroom or the laboratory have been accounted for.

The last two questions noted in Table XXXIII evoked rather depressing responses. Even if there could be found reasonable and valid explanations for the reactions noted here, the general state of mind they reveal is far from optimistic. In reply to Question 5, only thirty per cent of the teachers felt that promotions go to the deserving staff members in their school systems; thirty-eight per cent were in doubt; and one teacher out of every four felt that promotions did not go to the deserving staff members. The most pessimistic response of all turned up in the answers to Question 6. Nearly one-half (forty-seven per cent) of the entire group of beginning science teachers answered "No" to the question, "Does your present position offer favorable prospects for professional advancement?" Regardless of what "professional advancement" may mean to different individuals, a flat statement like this, coming from such a large percentage of the group, reveals a widespread attitude of discouragement. This is especially so when it is noted that another twenty-four per cent of the replies revealed uncertainty. Thus the exception rather than the general rule seems to be pointed up in the relatively small minority of science teachers (twenty-nine per cent) who saw prospects of professional advancement in their present positions.

In a final part of this section (not put in tabular form) the teachers were

asked, "How do you appraise the curriculum of your school?" Their responses were evenly distributed. Thirty-two per cent of the teachers said the curriculum in their school was good; thirty-two per cent appraised it as "adequate"; and thirty-five per cent of them felt their curricula were in need of revision. In connection with this they were asked, "Do you feel that you have adequate training to serve on and contribute to a curriculum revision committee or to work with other teachers in setting up a common learnings program in your school in which science would play an important part?" To this sixty-six per cent of the young teachers answered "yes" and thirty-four per cent replied "no." It is evident in these responses that the majority of the teachers felt capable of working in the improvement of their school curriculum. It should be kept in mind that ninety-six per cent of the administrators had called for training for work with "problems of the high school curriculum and the place of science in it."[6]

Therefore, although need for curriculum work and administrative demand for it have both been established and the majority of the teachers felt capable of doing the work, it would seem that less was being accomplished in this area than would have suited all parties concerned. The work reports of the teachers support this contention (see Table XXVII, page 87). It was found that only fifty-nine per cent had worked with other teachers in the study and possible revision of their school curriculum.

The Teachers State the Aims of Their Instruction. The following section deals with the statements from beginning science teachers about what they were trying to accomplish on their jobs. It is reasonable to assume that a teacher will direct his instruction toward those learning outcomes which in themselves constitute his perception of the purposes and principles of education. One of the purposes of this study was that of gaining some insight into the educational attitudes which the following questions were designed to bring out.

[6]See Table VII, page 33.

Table XXXIV

The Beginning Science Teachers Indicate the Outcomes Toward Which They Are Directing Their Instruction

| Question on Direction of Teaching: Question on Teaching Aims: | Per Cent of Teachers Who Responded: |
|---|---|
| In your present position do you feel your science teaching is mainly directed: | |
| 1. To give students an understanding of science and how it affects their lives? | 84 |
| 2. To develop in your students the ability to reason scientifically, to hold scientific attitudes in matters outside the science field itself, and to develop habits of accuracy, open-mindedness, inquisitiveness, etc.? | 71 |
| 3. To prepare students for college? | 48 |
| 4. To prepare students for jobs in your community that require science training? | 18 |

Table XXXIV presents the record of response to four questions about some of the aims of science teaching. In their replies to the first question, eighty-four per cent of the young teachers affirmed that one of their main efforts was directed toward giving students an understanding of how science affects their lives. This objective is distinctly in line with the main objectives of the administrators about the function of science teaching in general education (see Table V, page 28).

Seventy-one per cent of the respondents stated that they were directing their teaching toward the development of habits of critical inquiry and scientific reasoning in their students. This is a much lower per cent than that recorded by these same teachers in their recommendations for fundamentals of education for adult participation in contemporary society. There (see Table XXXII, Items 7

and 9) one finds ninety-seven per cent in one case and ninety-eight per cent in the other of teachers declaring the importance of disciplined thinking, and over seventy-four per cent in both cases recommending it as an essential in a training program. When we look back to Table XXV, page 82, seventy-one per cent of the teachers are found at work planning the science teaching "so as to combat propaganda and some commercial advertising."

Ninety-one per cent of the administrators had felt it important for training that a science teacher gain "an understanding of the nature of science as a method of critical inquiry," although only fifty-four per cent of them had rated it a minimum essential.[7] If any conclusion can be drawn from this examination of facts and opinions, perhaps it can only be that the value and importance of critical thinking is readily conceded. But it can be as readily concluded that neither administrators or teachers fully understand the nature of critical thinking as a subject of instruction. If this conclusion is even partially valid, it presents a strong argument that more extensive training in this area should be offered in the institutions preparing science teachers. Such courses as the Philosophy of Science or Formal Logic might well provide a firm foundation in this area. This might be especially so if given the further support of course offerings in the psychology of learning and instructional methods which investigated some of the mental process involved in critical thinking.

The responses to Question 3 in Table XXXIV prompt this observation. It is hoped that the forty-eight per cent of the novice teachers who are directing their teaching to prepare students for college are also directing their teaching so as to give students an understanding of science and how it affects their lives as well as to develop in their students the ability to reason scientifically, to hold scientific attitudes in matters outside the science field itself, and to develop habits of accuracy, open-mindedness, inquisitiveness, etc. If this is not the

---

[7] Table V, page 28.

case these teachers are denying the students under their direction the opportunity to experience the kind of instruction that is a well-recognized aim and demand for teaching to meet the real life needs of the pupils. Ninety-nine per cent of the administrators had called for training to prepare teachers to meet these needs (Table V, Item 1), and yet if college preparation is the main teaching aim of forty-eight per cent of the teachers it is clear that the pupils taught by these individuals are not being served, except in the case of those particular pupils actually going on to college. Of the remaining fifty-two per cent of the teachers who did not respond to this question on college preparation, it can be hopefully inferred that they are perhaps trying to balance the instruction so that all students alike may derive the valuable practical and intellectual advantages implicit in the study of science.

In Question 4 noted in Table XXXIV, it is seen that eighteen per cent of the beginning science teachers are directing their instruction to prepare students for jobs in the community which require science training. Perhaps one explanation for the low percentage recorded is that too few teachers see the logical and valuable connection between science studies in school and scientific work in the community. If instruction is so directed that young people can get jobs in local laboratories and research projects, it can accomplish at least two desirable things. First, community jobs can provide positive vocational training for many students who plan on science careers. And secondly, it can help many young people not quite sure of their future plans for careers to make intelligent choice on the basis of some actual experience in the area which they may choose as a life's work.

The attitude of these young science teachers, if it is reflected in their statements of teaching aims, can well be commended as one of mature and serious intent. Whether or not they are achieving success in their announced aims, it is clear that they have in general a fairly well-formed conception of the function

and values of scientific knowledge as a central element in our culture. They seem to perceive science as a study and a discipline extending beyond classroom, textbook, and laboratory, a study which offers broad and useful preparation for many phases of life in contemporary society.

# CHAPTER VIII

## SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

This investigation was based upon the premise that beginning science teachers and the administrators who hire them could offer judgments regarding desired competencies and programs of teacher training that would be of value to science teachers still in training and to the colleges and universities which train them. Questionnaires, designed to elicit judgments relative to the competencies and training backgrounds desirable in beginning science teachers, were sent to every science teacher in the state of Illinois who had taught from one to three years and to every third administrator on the comprehensive mailing list of the University of Illinois Mailing Service. The questionnaires sent to the beginning science teachers also asked for information relative to the professional duties they had assumed.

The author is aware of the limitations of the questionnaire as a research device.[1] These limitations were inherent in this study. But the need for an extensive sampling of judgments required use of the questionnaire technique for this study.

### A. SUMMARY OF THE FINDINGS AND THEIR IMPLICATIONS

The judgments of the administrators and the beginning science teachers show a high level of agreement on the competencies that should be expected of beginning science teachers and on the kinds of training suitable for the development of those competencies. This correspondence of judgment doubtless reflects a common

---

[1] See L. V. Koos, The Questionnaire in Education. New York: The Macmillan Company, 1928 and "The Questionnaire Is Questionable," Phi Delta Kappan, 29: 386-392, 1948, for analyses of these limitations.

awareness of the nature of the work that beginning science teachers are required to do and of the common weaknesses of such teachers in discharging their responsibilities.

Courses Taught by Beginning Science Teachers. One hundred and nineteen science teachers were involved in this study. Seventy-eight per cent of these teachers were serving in schools enrolling fewer than two hundred and fifty students. Thirty-seven had taught chemistry; sixty-three, biology; forty-eight, physics; and eighty-one, general science. All but three were teaching more than one science and all but twenty-seven were also teaching non-science courses. The data show that the beginning science teacher is typically required to teach two or more different science courses. It is clear, in fact, that many beginning science teachers are required to teach all of the science courses offered in their schools. High schools enrolling less than two hundred and fifty students can rarely afford the services of more than one science specialist. It is a difficult task for teacher training institutions to train teachers broadly enough to teach all of the sciences in the high school if, indeed, this training is to give such mastery of the various sciences that effective teaching may be expected. But the staffing requirements of the smaller high schools are apparently such that the task must be squarely faced. Although the data show that administrators often require science teachers to handle non-science courses, it would appear that this is done, partly at least, because deficiencies in the science teachers' subject-matter training necessitate giving them non-science courses and allowing other teachers in the school who have met minimum state certification requirements to handle some of the science offerings. If science teachers were broadly enough trained to meet minimum certification requirements in all of the sciences, it may be expected that the teaching of non-science courses by science teachers would rarely be required.

Subject-Matter Training of Beginning Science Teachers. How well prepared are these beginning science teachers to teach the courses they are assigned? In several respects their training in science is inadequate. The physics teachers had a median of sixteen hours, and only about twenty-five per cent had majors. Their total training in all fields of science ranged from 16 to 113 semester hours with the median falling at 48 hours (see Table XVI, page 62). It is quite obvious that many of these teachers are inadequately trained in their subject for them to be able to provide sound instruction to the children in their classes.

The subject-matter training of the chemistry teachers was somewhat better, for the median number of semester hours in that subject was twenty-three. But thirty per cent had less than a major in chemistry and another thirty per cent had less than a minor. The total number of semester hours in all sciences taken by these teachers ranged from twenty-five to one hundred and thirteen with the median at fifty-six (see Table XVII, page 64).

The median number of semester hours training in biology of the biology teachers was twenty-five, but many of them had an extremely poor balance of training in the various branches of biology. Although the state certification requirements theoretically prohibit a teacher from teaching any course for which he has had less than ten hours training in an accredited institution, the range of semester hours in biology reported by the biology teachers was less than three to a maximum of seventy-seven semester hours with a median of twenty-five (see Table XVIII, page 66, and Table XIX, page 67). Obviously, some of these teachers are not conforming to the state certification laws.

Twenty-two of the eighty-one teachers of general science did not have majors in any field of science. The number of semester hours of training in all sciences received by these eighty-one teachers ranged from sixteen to one hundred and thirteen with the median at forty-eight.

The number of semester hours training in the various branches of science which these general science teachers have taken reveals severe inadequacies. General science should be an absorbing, interesting, and vital educational experience for young people. It is the first formal contact with the broad fields of science for youngsters in our schools. Unfortunately, it is the only course in science that many will ever take. It will presumably be but a superficial contact unless it is taught by teachers who have been reasonably well trained in the fields of science represented in the course. But the median number of semester hours of biology taken by these teachers was only fifteen; the median in chemistry was fifteen; the median in physics was ten; and but an insignificant number had taken any work at all in astronomy, meteorology, or the earth sciences. Four of these teachers had had no training at all in biology; ten had taken no work in chemistry; and fourteen reported no work in physics (see Table XX, pages 70 and 71).

Could these glaring inadequacies in subject-matter training lead to inspiring and educationally profitable general science courses? We think not. It is more likely that such limitations of training have resulted in boring, superficial classes, and that these, in turn, are partly responsible for the declining enrollments in physics and the low enrollment in chemistry courses reported nationally. For many young people may refuse to elect these courses as a result of their unfortunate experiences in poorly taught general science courses.

Training in Education. The one hundred and nineteen science teachers who cooperated in this study were, as a group, even more deficient in their background in education. Although the median for all courses in education was twenty-one semester hours, the group median was zero semester hours of course work in tests and measurements; zero semester hours in curriculum; three semester hours in educational psychology; about five semester hours in practice teaching; and a median of about five semester hours in all other courses in education combined. What this extremely limited training implies for the professional success of the

beginning science teachers will become clear from an analysis of the duties and responsibilities they had assumed.

The Work of the Beginning Science Teacher. What does the beginning science teacher do on the job? What responsibilities does he discharge? What duties must he perform? What are his objectives? It is from the data which answer these questions that we may determine the adequacy of the beginning teacher's training in subject fields and in education. These duties and responsibilities are reported by categories below. In each category they are presented in the order of frequency with which they were enumerated by the responding teachers.

Teaching Objectives. Almost all of the responding teachers indicated that they had attempted to focus their subject fields on the personal problems of young people and on important social issues. Ninety-two per cent report that they had directed their teaching toward the conservation of natural and human resources. Eighty-five per cent had attempted to apply the science they were teaching to problems of personal and community health. Eighty-one per cent specifically indicated that they had worked to focus their teaching on the needs of their students as they saw them. Eighty per cent had employed the resources of the communities in which they taught and seventy-six per cent had placed emphasis on the application of the sciences they taught to the leisure time activities of their students. Seventy-three per cent worked on consumer problems with their students, and seventy-one per cent reported that they had analyzed propaganda and the validity of commercial advertising claims in their course work. Sixty-eight per cent reported attempts to help their students gain a better understanding of the impact of science and technology on our society.

The questionnaires used in this study did not provide opportunities for the respondents to assess the relative importance of a wide variety of teaching objectives. However, a sufficient range of teaching objectives was provided (through

the indirect means of asking what the respondent had done in his teaching) to enable the investigator to see something of the hierarchy of objectives accepted by the teachers. For example: eighty-four per cent had emphasized the effects of science on the lives of their students, and seventy-one per cent had attempted to develop critical thinking, accuracy, open-mindedness, and, in general, "scientific attitudes and abilities" in their students, while only forty-eight per cent reported teaching their sciences with college preparation as a major goal, and only eighteen per cent had directed their science teaching toward vocational preparation.

The achievement of this range of commonly accepted objectives would tax the ingenuity and professional skill of the best trained and most erudite teacher. When one compares these aims--laudable though they may be--with the responding teachers' backgrounds of training in science, and more particularly in education, one is left with the feeling that these teachers have been attempting the impossible. To do the things that the majority of the responding teachers have indicated they have been doing with the limited training they have had in educational theory, curriculum, the construction and use of diagnostic and evaluative instruments, and--above all--in modern psychology would appear to the writer to be comparable to attempting to perform intricate surgical operations with a background training that consisted of a few semester hours of textbook anatomy and a short period of "clinical" observation and gross dissection on cadavers.

But equally disturbing is the fact that large numbers of these teachers have been attempting these things in their classrooms with but a modicum of training in the sciences themselves. A teacher with ten to twelve hours of physics, or chemistry, or biology may sometimes "get by" in teaching his subject by staying close to his textbook, "keeping ahead" of his students, and learning with them as the course proceeds. But to do well the things these teachers have said they have

been doing requires a thorough mastery of subject matter and an understanding of the relation of science to society. The goals of these teachers would, in general, appear to be sound ones. But they are not achievable, in the writer's judgment, except from a sound foundation of competence in science fields.

Work Done by the Responding Teachers. The work of the beginning science teacher is complex, varied, and demanding, if the reports of the responding teachers are a valid index. Ninety-four per cent had found it necessary to search the literature in order to keep abreast of recent developments in science pertinent to their work as teachers. Eighty-seven per cent reported that the care of scientific equipment was in their charge and approximately the same per cent reported that they were required to inventory and order the scientific equipment and materials they used. Well over half the respondents indicated that it had been necessary for them to repair some of the scientific equipment used in their classwork. It is particularly interesting to note that over three-fourths of the respondents reported that they had used apparatus in their teaching which they had not used before in any of their training work. Scientific equipment and materials are expensive. It seems quite likely that some of it is being used badly and allowed to deteriorate simply because the institutions preparing teachers for their work have neglected to provide their trainees with needed experiences in using and maintaining such materials. Of course, it cannot be expected that sound training in the use and care of scientific equipment can be given to teachers in training if they take so few hours of work in science and science education that no opportunity is afforded for such experiences. But it would appear to the writer that teacher training institutions have the responsibility both of determining and enforcing minimum programs and in making those programs functional in terms of the high school science teacher's future work. And that work clearly includes the care and use of scientific equipment.

Another aspect of the work of the beginning science teachers is in connection with their professional and personal contacts with young people. Seventy-six per cent of the respondents indicated that they had counseled boys and girls in their classes and seventy per cent indicated that they had been confronted with some unusual discipline cases from time to time. Sixty-seven per cent reported that they had attempted to provide for the individual differences they found in their classes. Fifty-eight per cent had attempted to help their students gain maturity in understanding proper boy-girl relationships and forty-five per cent indicated that they had taught some phases of sex education as a part of their work. Nearly half had worked with young people's groups in their communities and forty-four per cent had found it necessary to attempt remedial work in mathematics and reading in order to aid the students under their supervision. One wonders with what success this remediation was carried out when their reported training is so deficient in this regard.

There were many other duties associated with the professional work of these teachers. Over ninety per cent had worked with other teachers on various school problems. Eighty per cent had helped in the planning of extra-curricular activities. Sixty-three per cent had helped administer standardized tests, and forty-three per cent had been required to interpret the results of diagnostic tests. Well over half had been involved in curriculum studies in their respective schools and almost all had chaperoned school parties and had helped plan school social functions.

This, then, was the work of the beginning science teachers in the state of Illinois as reported by the teachers themselves.

The Teacher's Job as Seen by the Administrator. But how did the employing officers of these teachers see the role of the science teacher? Did they want teachers who were capable of performing the wide variety of tasks that the

beginning teachers stated they did perform? Or did they ask merely for teachers capable of teaching a science course from a standard textbook?

The administrators who employ the teachers prepared by Illinois colleges and universities apparently expect much of their beginning science teachers. They want them well trained in teaching skills and techniques. They want teachers who can plan their courses to best meet the varied needs of their students. They want teachers who can direct the learning process so that the students become more and more self-educative. They want teachers who can select teaching aids soundly and use them effectively. They want teachers who can maintain sound classroom discipline.

The administrators are apparently fully aware of the importance of proper use and maintenance of scientific equipment and supplies for they ask for teachers who are well acquainted with the use and care of such materials.

They ask for teachers who are not only well trained in science but who, in addition, have learned how to apply their science to the everyday problems of children in the areas of health, conservation, consumership, family living, and use of leisure time. They want their science teachers to help youngsters gain understanding of the impact of science on our technological society. They place high on their list of desiderata teachers who are capable of teaching their sciences scientifically--who can help youngsters improve their abilities to tackle science problems critically and effectively.

Extremely high on their list of wants are teachers who have learned to understand boys and girls. The importance that they place on such understandings make it quite clear that they want science teachers who are skilled in teaching science both as a body of knowledge and as a tool for helping boys and girls mature intellectually, ethically, and emotionally. They ask for teachers who know how to diagnose individual differences and how to help individual students on their

problems. They want their beginning teachers to be versed in sound techniques of counseling. In all of these demands, the administrators ask for teachers who are capable of doing the very things that the beginning teachers themselves say that they are doing, or are attempting to do.

These employers of teachers ask for men and women who understand the purposes and organization of the American public school and who are capable of accepting their share of the responsibility of carrying on the school's functions. They want teachers who can work harmoniously with their colleagues on school problems and who are capable of participating effectively in the life of the community as well. They want teachers who can read professional research reports with discrimination and intelligence and who will apply valid findings to their own work.

They want teachers who are broadly trained in the various fields of science. Yet they are apparently aware of the dangers of a thin smattering of subject matter. They ask for thorough grounding in the fields of biological and physical science, and the majority prefer that the beginning science teacher have received, in addition, some penetration in one science area. But they ask for teachers who know the relatedness of the fields of science and who can teach the various sciences of the high school curriculum effectively if called upon to do so.

They ask, in short, for teachers who are well trained both in subject-matter fields and in professional skills. Their demands are representative of the work of the beginning teachers as briefed in the preceding section. These demands, and the work the beginning teachers report that they are doing, both seem to exceed by a dangerous margin the training the teachers have received. It is of particular interest, therefore, to see what the beginning teachers have to say about training programs.

How Beginning Teachers View Teacher Training Programs. The beginning teachers favor specialization in broad fields such as physical and biological science

rather than in more specific areas such as chemistry and zoology. They would prefer science courses designed and taught specifically for prospective teachers rather than courses designed for their general education value or for the preparation of research workers and specialists in other fields. They would like for science courses to provide a greater emphasis on the effects of science and technology on our society. They prefer less emphasis on the technical aspects of science and more emphasis on the practical aspects that will be of definite use to them in teaching.

Eighty per cent or more of the respondents feel that attention to each of the following subject areas is essential in the training program of science teachers: diseases and disease transmittal, the work of public health and health agencies; the growth and development of the human organism from prenatal stages to maturity; physiology of sex and the problems of sexual adjustments, marriage, and related matters; and the maintenance of mental health.

From one half to three fourths of the respondents believe that the following are essential in the training program of science teachers: work leading to a coherent and rational picture of the world and to a sound personal philosophy of life; propaganda analysis; food requirements and metabolic changes in man; practice in using the scientific method in solving practical problems; study of the effects of science in the development of the modern industrial power age; consumer education; the nature of man, his behavior, and cultures; and work leading to the development of democratic principles which are consistent with the findings of science and which are workable in modern technological society. Over half felt that attention to research and the conditions that must be fulfilled before generalizations can be made was essential to the training program.

Their demands for help from departments of education were no less emphatic. (Of course, some of the foregoing may represent areas more suitably taught in

education courses than in science courses.) Eighty per cent or more felt that attention to each of the following was an essential of a sound training program: the problems of boys and girls and the personal characteristics they need to meet these problems; the problem of motivation; techniques and methods for achieving educational goals; the nature of individual differences; and the interests and needs of boys and girls at different grade levels. Over half of the respondents felt that training in the teaching of controversial issues was an essential.

General Conclusions. It is evident from this study that teachers are typically required to handle more than one science course. Often the beginning teacher is the science teacher and must teach all of the science courses offered by his school. The administrators overwhelmingly request science teachers with sufficient training to handle well the several sciences offered. Yet it is quite apparent from the reports of the responding teachers that a large majority are not so trained. Many are narrowly trained, many have a large number of semester hours concentrated in one subject-matter field and few or no semester hours of work in other science fields. Many others had but meager preparation for any of the science subjects they were teaching or had taught. But these teachers, like the administrators, recognize the limitations of such training and favor broad training in such fields as physical science and biological science rather than narrow specialization. It is the writer's belief that each science teacher should probably have a minimum of sixty semester hours of training in science spread over the biological and physical sciences and that these sixty hours should include a strong major in one of the areas. The sixty hours represents, of course, an arbitrary figure. But, as will be indicated in the section on specific recommendations which follows, this judgment closely parallels that of the Cooperative Committee on Science Teaching of the American Association for the Advancement of Science.

Training in the subject matter of science is by no means all that is lacking in the training programs of these beginning teachers. They faced many and complex responsibilities in their first years of teaching but their training in education was even more deficient than their training in science. If the skills required for effectively discharging the many duties the great majority of these teachers had assumed are not developed through training programs the beginning teacher will be crippled in his work and his students will suffer from his ineptness. These professional competencies should be developed through the teacher preparation program.

Both the subject-matter needs and the professional needs of the beginning teacher imply the most careful reconsideration of college staffs of what they offer and of how they themselves exemplify effective teaching. It is too much to expect, for example, that teachers trained in college science classes from single textbooks, with a diet of formal lectures, and with standardized and formalized laboratory experiments will, from such a process, gain skills in helping young people search references for answers to their questions, in discussing science questions with competence, or in setting up laboratory equipment to answer real problems. It is too much to expect that a diet of lectures by instructors in education on instructional techniques will help the prospective teacher acquire skills in such instructional techniques. Textbooks, formalized laboratory experiments, and lectures all have their place, of course, but cannot produce many important skills required by those who are to teach science to young people.

The general education background of the teacher is of great importance. High school students, whether college bound or not, need a kind of emphasis in their science courses which fits their present needs and interests and which serves the communities in which they live and their future needs as citizens. The teachers who cooperated in this study have tried to provide this emphasis. But in order

for them to do so effectively their subject-matter and professional training must be undergirded by a sound program of general education. For the science teacher to join his colleagues in other teaching fields in an effective common endeavor to help young people understand and adjust satisfactorily to our complex modern world he, himself, must have developed the understanding and maturity to have made his own satisfactory adjustment. To have done so--to be a well adjusted person and an informed and capable co-worker with specialists in other fields and with the adults of his community--the science teacher must have had a background on the collegiate level in the humanities, the social sciences, and the communication arts. He must be able to communicate with grace and clarity. He must know and appreciate the richness of our cultural heritage. And he must know and understand --deeply and well--the background and growth of western culture and the traditions of freedom, equality, and justice that comprise the American dream. He should recognize the broad fields of science as a social force that is inextricably interdependent with other social forces. He should understand our social institutions and the fundamental issues that face our people and the peoples of the world today. Only through such understandings can the science teacher effectively discharge the responsibilities he is called upon to accept today and--on the evidence of the data in this study--he has tried to accept. The teacher training institutions must help him to acquire those understandings and wed them to his subject-matter competence and his professional skills.

## B. RECOMMENDATIONS FOR PROGRAMS OF TRAINING HIGH SCHOOL TEACHERS OF SCIENCE

Science Subject Matter. The data in this study show that the teachers who responded to the inventory meet the state requirements to teach science in Illinois[2] but fall short of the sixty hours of science training recommended by the

[2]To qualify as a science teacher the state of Illinois requires sixteen semester hours of science and ten semester hours in the science subject taught.

Cooperative Committee on Science Teaching.[3] It is the opinion of many science teachers that only sufficient training in science to meet the requirements to teach in the state of Illinois gives the teachers very meagre equipment for effective science teaching. It is not argued that accumulating semester hours in the field of science guarantees that the prospective science teacher will be a success at teaching science but such training certainly is one of the prerequisites of successful teaching. It appears that the colleges and universities of the state must assume the responsibility if more rigorous requirements to teach science in the state of Illinois are to be made. These teacher training institutions may well take the leadership in (1) agreeing among themselves on what a minimum program of training for science teaching should consist of and in (2) adopting and carrying through such a program to improve the training of science teachers in the state.

Since the majority of beginning science teachers find employment in small high schools[4,5] where enrollments do not justify the employment of more than one science teacher, it appears logical that they should have training in the fields of both the biological and physical science if they are to qualify as the science teachers of the school.

Both in view of what administrators want and what beginning science teachers report that they are required to do on the job, it appears imperative that the training programs for teachers provide a broad background in science subject matter.[6,7] From the experience of the writer the sixty semester hours recommended

---

[3]The Cooperative Committee on Science Teaching, "The Preparation of High School Science Teachers," School Science and Mathematics, 42:649, October 1942.

[4]See Table XII, page 56.

[5]See Table XXVIII, pages 91 and 92.

[6]See Table XXII, page 75.

[7]See Table VIII, pages 36 and 37.

by the Cooperative Committee on Science Teaching[8] should be the minimum requirement. These sixty semester hours of training should be so distributed that the teacher gets at least one course in chemistry, physics, biology and earth science. The first course for each of these may well be six to eight semester hours with laboratory, except for biology where ten to twelve semester hours may well constitute the requirements for a first course because it embraces such a broad area of science. Here the teachers need training in zoology, botany and physiology at the minimum. A second course of six to eight semester hours should be required in three of these and a third course of six to eight semester hours should be required in one of the four sciences mentioned. This requirement may conceivably follow a pattern such as this:

| | 1st Course | 2nd Course | 3rd Course | Total |
|---|---|---|---|---|
| Chemistry | 8 | 8 | 6-8 | 22-24 |
| Physics | 8 | 6-8 | --- | 14-16 |
| Biology | 12 | 6 | --- | 18-18 |
| Earth Science | 6 | --- | --- | 6-6 |

Other patterns which use majors in other science subject-matter fields may profitably show the same general distribution of course hours. In any event the teachers should have a reasonably strong major in one field and if at all possible a second major in another science area. If biology is the second major, twenty-two to twenty-four semester hours should be the minimum number required.

Ideally, these courses of instruction offered by the colleges and universities which train teachers should be specially designed for the training of

---

[8]The Cooperative Committee on Science Teaching, "The Preparation of High School Science Teachers," School Science and Mathematics, 42:649, October, 1942.

teachers of science[9] just as courses in chemistry may be specifically designed for pre-medics or physics courses may be specifically designed for pre-engineers. Not only should the content of these courses be carefully selected for their pertinence to the high school teacher's work, but the methods of teaching them should be lessons in themselves on how the science being studied can be presented for the best understanding of everyone in the course.[10,11]

Ideally, college instructors who teach these science courses for prospective science teachers should be cognizant at all times of the problems of teaching science in high schools. It would be desirable if they could have had actual experience in teaching at the high school level. Some type of administrative machinery should be devised in the teacher training schools whereby science instructors can keep in constant touch with the trends of science teaching on the high school level, perhaps by direct observation through periodic visits to the secondary schools of various sizes.

In these science courses offered by the teacher training institutions prospective science teachers should have opportunity to use the various kinds of science equipment that they will later use on the high school level. They should be given the opportunity to learn the details of proper care and storage of all science equipment and materials that may be used in secondary school science courses.[12,13] Much science equipment and material deteriorates rapidly from improper use and storage thus making science courses needlessly expensive to the tax payers of the public schools.

---

[9]See Table XXVIII, page 84.

[10]See Table XXIII, page 78.

[11]See Table XXVIII, page 84.

[12]See Table XXIV, page 80.

[13]See Table IV, page 26.

The science subjects taught in the teacher training institutions should provide prospective science teachers with opportunity to estimate accurately the amount of science equipment and materials needed annually for science courses in the high school.[14,15] This training should involve instruction in how to specify and order such equipment. Very often the beginning teacher has not had training in these skills and is at a loss when duties of this type befall him. Consequently he learns by trial and error at the expense of the school in which he teaches.

College instructors of the science courses designed to train science teachers should use field trips[16,17] whenever feasible to show at first hand the topic of science being studied. Whenever certain aspects of the science studied lend themselves to the use of community resources (as biology and earth science often do) the prospective science teacher should be given experiences in the use of such resources.

Various methods of measuring the progress of learning in science should be part of the training that a science teacher receives.[18,19] Such methods of measurement should help the teacher to determine the achievements of students in (1) comprehending science principles and ways of applying them, (2) factual recall necessary for understanding the science studied, (3) using various laboratory techniques to get the answers to science problems, and (4) in using a wide variety

---

[14] See Table XXIV, page 80.

[15] See Table IV, page 26.

[16] See Table XXIII, page 78.

[17] See Table III, page 24.

[18] See Table XXIII, page 78.

[19] See Table III, page 24.

of reference materials in the study of science.

The testing programs in science subjects on the college level should be lessons in themselves in how to use a testing program and may well be used as important teaching aids as well as devices to measure achievement in science work of the teacher trainees.

The science offerings in the teacher training institutions can most effectively be developed through continuous cooperation between members of the biological and physical science departments.[20,21,22] This planning should be designed to ensure that the teachers in training understand the interrelationships of the several branches of science.

Opportunities should be given whenever possible for developing the initiative of the prospective science teachers by permitting them to participate actively in the preparation and presentation of assignments and performing demonstrations for their own groups.

In these science subject-matter training programs instruction should be given on the sources of information science teachers may turn to in order to keep up with recent developments in the various science fields. They should learn of the benefit they may derive from supporting and participating in professional science and science teaching organizations.[23,24] Too often science teachers become apathetic to the professional side of teaching and this attitude is one factor which stands in the way of recognition by the public of teaching as an important

---

[20] See Table XXI, page 74.

[21] See Table XXVIII, pages 91 and 92.

[22] See Table XXXII, pages 104 and 105.

[23] See Table XXIV, page 80.

[24] See Table IV, page 26.

profession. The teacher training schools have an obligation to do more in fostering pride in those who elect to become members of the important and difficult profession of teaching.

Student Teaching. Teacher training institutions should make every effort to select high schools of various sizes which are doing a good job of science teaching and to develop plans with the administrators and science teachers of these schools for an effective program of supervised student teaching.[25,26,27] Such a program would doubtless require that the teachers of such schools receive some remuneration from the teacher training schools for their work with the prospective teachers. In the student teaching experience the prospective teachers should be permitted to teach not only their major but also their minor subject as well. This student teaching experience should include planning and presenting units of study, planning and using demonstrations, selecting and using visual and audio aids, operating machines for showing film strips and movies, planning and conducting field trips, planning and supervising science projects, devising and using instruments for measuring student progress, supervising laboratory work, checking student papers, caring for equipment and supplies, preparing solutions for science work, and, in general, participating in all the activities commonly required of a science teacher in the operation of a school.[28,29,30] This period of practice teaching should be at least one semester in length and should involve no less than

---

[25] See Table XXIX, page 97.

[26] See Table XXX, page 98.

[27] See Table IX, page 41.

[28] See Table XXIII, page 78.

[29] See Table XXIV, page 80.

[30] See Table IX, page 41.

two and perhaps no more than four hours of class responsibility per day. During this internship the student teachers should be given opportunity to become acquainted with the duties of the attendance officer of the school and with the counseling program and the duties of the faculty members who participate in it. They should attend faculty meetings, participate in any curriculum studies that may be in progress, and attend meetings of school clubs, assemblies, drama productions, musicals, and athletic contests. The student teachers should be given full opportunity to secure a good idea of the over-all operation and organization of the school, and the philosophy of the school staff toward education on the secondary level.[31,32] During this period of internship the student teachers should have opportunity for frequent contacts with the supervising teacher from their teacher training schools. The purpose of these contacts should be for resolving any problems that they may have of applying their training to the actual job of teaching. The student teaching experience should give them opportunity to work with all types of students:[33,34] excellent students, average students, slow students, problem students, student leaders, in fact as wide a cross section as can be offered. An opportunity to associate with teachers of other subject-matter fields in order to gain an insight into their responsibilities in the total school program would be beneficial. In fact this internship should be as comparable to the job of full-time teaching as it is possible to make it.

Training About Boys and Girls. Successful science teachers soon find that their primary job on the secondary level is teaching and guiding boys and girls in such a manner that they may achieve to the fullest the objectives of education

---

[31] See Table XXVI, page 84.

[32] See Table XXVII, page 87.

[33] See Table XVI, page 80.

[34] See Table VI, page 31.

set up by the school. The beginning science teachers who cooperated in this study expressed a need of learning much about the nature of boys and girls in their teacher training program.[35,36] Training in the understanding of boys and girls should be studied from as concrete a situation as possible. There is a danger that prospective teachers will become immune to sound theories unless they see them exemplified in actual practice. Training in psychological and educational theory has too often dealt largely in abstractions.

Prospective teachers need to study the complete growth of children.[37,38] They need to know as much as possible about how children develop physically, emotionally, intellectually, and as members of social groups. They need to understand, as fully as possible, the characteristics of adolescents of secondary school age and the problems these students are likely to encounter. The nature of individual differences; the range of abilities commonly encountered in the classroom; and how to work effectively with both slow and exceptional students should be studied by all science teachers.[39,40,41]

Science teachers are in an enviable position to contribute to the attainment of intellectual honesty, suspended judgment until the facts are known, disbelief in superstitions, and of unprejudiced attitudes in young people. They can also

---

[35] See Table XXXI, page 100.

[36] See Table VI, page 31.

[37] See Table XXXII, pages 104 and 105.

[38] See Table VI, page 31.

[39] See Table XXXI, page 100.

[40] See Table XXVI, page 84.

[41] See Table VI, page 31.

help young people to improve their skills in identifying and attacking problems through rational and critical means. But these attitudes and skills require effective teaching techniques if they are to be developed in young people. The training institutions should help teachers in training to develop such techniques.

The complexity of American society demands a sound guidance and counseling service in the schools for boys and girls.[42,43] The philosophy of many school staffs holds that guidance is one of the responsibilities of all teachers. Students will often look to teachers for guidance and counseling in many ways and if the beginning science teachers are to perform these duties effectively, training in this area is a necessity. It may be added that the services of guidance and counseling on the secondary level are not the only ones that need study and improvement. The same can be said in regard to the guidance and counseling of prospective science teachers on the college level. These services need serious attention and planned improvement.

Beginning science teachers need to become acquainted with the use and interpretation of various diagnostic instruments used in the secondary schools.[44,45] Understanding the use of and interpreting the results from such instruments as interest inventories, social adjustment scales, and tests of mechanical aptitude, mathematical aptitude, and science aptitude may go a long way in helping science teachers understand more fully the boys and girls under their direction and thus make it possible for them to plan more effectively how to meet student needs.

---

[42] See Table XXVI, page 84.

[43] See Table VI, page 31.

[44] See Table XXVII, page 82.

[45] See Table VII, page 33.

Related to diagnosis is the area of remedial work.[46] Beginning science teachers need to become acquainted with methods of helping students who show deficiencies in reading, mathematics, and in ability to express themselves. It probably is the hope of every high school teacher that he will not have to be concerned with such disabilities. The facts, however, require that every teacher provide continuing help in the improvement of these basic skills. Science teachers must know how to diagnose deficiencies and help students overcome those that are remediable. The range of abilities of students in the secondary school have become wide and the needs for the students who show deficiencies are as important as the needs of students who show proficiencies.

The teacher training institutions need to be concerned about the development of the teacher as a person.[47,48,49] Success of teachers in working with students, faculty members, and members of the community depends to a large degree upon their personality. This area is of utmost importance when so many citizens live and work at such a fast tempo. The numerous tensions and pressures that they encounter go a long way to impair efficiency and the better adjusted the beginning science teachers may be the better they may cope with their own problems and the problems of others.

It is recommended that training in this broad area of psychology should embrace work in the following:

General Psychology

Psychology as Applied to Education (Learning Theory)

---

[46] See Table XXVI, page 84.

[47] See Table XXVII, page 87.

[48] See Table XXXII, pages 104 and 105.

[49] See Table VII, page 33.

Psychology as Applied to Adolescents

Psychology of Personality and Social Adjustment

Interpretation and Use of Diagnostic Instruments in School Programs

Remedial Problems in the Secondary School

Guidance and Counseling on the Secondary Level

If all of the above areas were organized into as many three semester hour courses this would add 21 hours to the 60 hours in science already recommended: a total of 81 semester hours to this point. It is doubtless possible to combine the work in some of these areas into a single course. The writer sees possibility of this in the areas of Interpretation and Use of Diagnostic Instruments in School Programs and Remedial Problems in the Secondary School. This would reduce the number of semester hours of work required in psychology from 21 to 18.

Other Courses in Education. The prospective science teachers should have training in the organization of the secondary school,[50,51] the place of science teachers in this organization, the contributions they will be expected to make to the successful operation of the school, the management and organization of the classroom, ways and means to maintain an orderly yet uninhibited atmosphere for free expression and learning in the classroom, and the importance and necessity of learning how to work with other teachers in arriving at solutions to problems within the school. This course may well develop the place and the function of the secondary school in American society.

A trend toward increased activity in curriculum development in Illinois high schools points toward a definite training need. Of the 119 science teachers reporting in this study, only 30 (about 25 per cent) had training in the field of

---

[50] See Table XXIII, page 78.

[51] See Table VII, page 33.

curriculum. It is the belief of the writer that a study of the curriculum of the secondary school and the place of science in it is a pressing need in the education of the science teacher. Only one branch of science teaching, chemistry, is represented on the State Steering Committee of the Illinois Curriculum Program. The physics, biology and general science teachers of the state have no organization that represents them in the state and it is the author's belief that an overwhelming majority of the science teachers are unaware of the full import of the Illinois Curriculum Program. It is quite likely that lack of training in curriculum underlies the lack both of interest and participation in state programs of curriculum development. Should we grant that the majority <u>are</u> aware of the importance of the state programs they necessarily have to start from scratch in their study of curriculum problems. Such a study can be expedited and a better understanding between science teachers and other teachers of the school can be facilitated when the science teachers are acquainted with problems of the curriculum and the place of science in it. Furthermore the study of the curriculum is a continuous process in a dynamic school. Therefore a course in the fundamentals of curriculum development[52,53] may well be a need in the training of beginning science teachers.

The beginning science teachers need a course in the teaching of science before they enter upon their venture of student teaching.[54,55,56,57,58,59,60]

---

[52] See Table XVII, page 87.
[53] See Table VII, page 33.
[54] See Table XXIII, page 78.
[55] See Table XXIV, page 80.
[56] See Table XXV, page 82.
[57] See Table XXVI, page 84.
[58] See Table XVII, page 87.
[59] See Table III, page 24.
[60] See Table IV, page 26.

This course should be taught by an instructor who has had thorough training in both the fields of science and education and stands in good repute with the staffs of both departments. This course will necessarily draw upon the acquired knowledge in science, education, humanities, and other fields studied by the prospective teachers. In this course all aspects of science teaching--teaching techniques, lesson planning, laboratory work, measurement of student progress, use of audio and visual aids, care of equipment and supplies, and the purposes of science teaching on the secondary level--may well be studied.

The beginning science teachers should become fully acquainted with the research on effective college preparation and with the techniques of teaching that prepare boys and girls of ability so that they may qualify for higher education and succeed in college.[61] This may well be a part of this course in the teaching of science.

These three areas of education may conceivably be covered in courses of three semester hours each. This would add another nine semester hours to the training program, making a total of 87 semester hours of training.

Communication Skills and the Humanities. Throughout the training program of prospective science teachers attention should be given to the improvement of communication skills.[62] Instructors should make concerted efforts to give their students every opportunity to plan and write out various assignments in courses. Probably more important in some cases will be opportunities that can be made available to the prospective teachers to prepare a body of material and present it to their fellow students. Prospective teachers need many opportunities to appear before groups of people and to think while on their feet in order to feel at ease

---

[61] Illinois Secondary Schools Curriculum Program, New College Admission Requirements Recommended, Bulletin No. 9, Office of the Superintendent of Public Instruction, Springfield, Illinois, September, 1950.

[62] See Table VII, page 33.

in the classroom. The requirement of a course in composition and one in speech may be desirable--certainly for those who show deficiencies in these skills.

The increased expansion of the services of the school into community activities brings teachers more often into contact with the adults of the community. In many cases, especially in small communities, the school becomes a major focus of social and civic activity. The individual teacher has responsibilities here. More important than this is the fact that the teacher is first a citizen and should exemplify good citizenship in his personal life. The program of science teacher training should provide the basic education necessary to fit teachers for their social and civic responsibilities.[63,64,65] The maturity with which the beginning science teachers assume such responsibilities will depend, of course, not so much on the number of courses taken in the field of social studies as in quality of the courses offered. The writer does not presume to suggest what such courses should be. But it seems clear that every teacher should have a basic grounding in history, economics, sociology, and anthropology. It is suggested that course planning in the division of humanities be a cooperative venture with representatives from the departments of science and education. It is hoped that such cooperative planning will enable future beginning teachers to achieve a much better understanding of our present technological society and the relationship of science to it than our present teachers have probably developed.

The proposed courses in composition and speech may well be three semester hours in length each. It is believed that two courses of three semester hours each in the social studies could produce significant results in the development

---

[63] See Table XXV, page 82.

[64] See Table XXVII, page 87.

[65] See Table VII, page 33.

of the understandings considered as minimum essentials in the training of science teachers. These courses would add twelve more semester hours to the recommended training program of the prospective science teachers and would raise the total to 99 semester hours.

Other Courses in the Training Program. The courses that the prospective science teachers will take in mathematics will be dictated by the courses selected in science. A science teacher majoring in biological science will not need as much mathematics as one majoring in physical science. It is conceivable that from six to nine semester hours of mathematics may be required as prerequisites for the science courses. The number of semester hours required will depend on the proficiency attained by the prospective science teachers in their high school mathematics. Assuming six hours as a minimum in mathematics, the recommended program for science teachers would be raised to 105 hours.

On the basis of an average of sixteen semester hours of training per semester the prospective science teachers can amass a total of 128 semester hours in four years of work. Student teaching would require a minimum of 5 semester hours credit. This would leave only 18 semester hours for elective courses during the four-year program. In order for a prospective science teacher to take the proposed program and to take work in other areas including those required by the colleges for graduation, he may find it necessary to attend summer sessions or to continue work beyond the fourth year. The first semester of a fifth year of training might be designed as an internship semester for student teaching. The second semester could then be devoted to work toward a Master's degree or to additional elective courses.

A summary outline of the foregoing recommended program in science teacher training is as follows:

| Department of Study | Minimum Semester Hours of Training |
|---|---|
| Science | 60-64 |
| Education | 27 |
| Student Teaching (or Internship) | 5-10 |
| Humanities | 12 |
| Mathematics | 6- 9 |
| Total | 110-122 |

Teacher training has too often been of secondary importance in institutions that prepare young people for teaching. The teacher training institutions have an obligation to plan and coordinate their instructional programs for the preparation of competent teachers. The upgrading of the educational profession will not be accomplished by turning out poorly trained and incompetent science teachers. The numerous deficiencies revealed in the training of many science teachers in this study cannot help but become a concern of those teacher training institutions which are interested in giving the high schools of Illinois more competent science teachers.

# BIBLIOGRAPHY

## A. BOOKS

Guilford, J. P., Fundamental Statistics in Psychology and Education. New York: McGraw Hill Book Company, Inc., 1950, 633 pp.

Report of the Harvard Committee, General Education in a Free Society. Cambridge, Massachusetts: Harvard University Press, 1945, 267 pp.

Smith, B. Othaniel, William O. Stanley, and J. Harlan Shores, Fundamentals of Curriculum Development. New York: World Book Company, 1950, 780 pp.

## B. PERIODICAL ARTICLES

Burnett, R. Will, "Opinions of Science Teachers and Their Implications for Teacher Education," Teachers College Record, 42:709-719, 1941.

The Cooperative Committee on Science Teaching, "The Preparation of High School Science Teachers," School Science and Mathematics, 42:636-650, 1942.

Mallinson, George G., "A Report to the N.A.R.S.T. on the Activities for 1950-1951 of the Cooperative Committee on the Teaching of Science and Mathematics of the A.A.A.S.," Science Education, 35:189-190, October, 1951.

Reeve, W. D., "Subject Matter Specialization in the Training of Teachers," Teachers College Journal, 17:29-30, November, 1945.

Sulton, C. Traver, "Teachers Failure in Science Teaching," School Science and Mathematics, 44:549-553, 1944.

Winans, Ada E., and Jean, F. C., "Educational and Professional Status in the Public Schools of Colorado," Science Education, 29-30:133-136, April, May, 1945.

Wright, William A. E., "Subjects Taught by Science Teachers in Third Class School Districts of Pennsylvania," School Science and Mathematics, 45:45-52, January, 1945.

## C. UNPUBLISHED MATERIALS

Burnett, R. Will, "Report to the University of Illinois Committee on the Preparation of Secondary School Teachers of Science," unpublished, 1950.

# APPENDIX

COLLEGE OF EDUCATION

UNIVERSITY OF ILLINOIS URBANA, ILLINOIS

May 16, 1950

Dear Fellow Teacher:

This letter and the accompanying confidential inquiry form is being sent to a selected group of science teachers throughout the state. It is being sent at this time of the year in order to get information from those teachers who have completed one, two, or three years of teaching which required the teaching of one or more courses of science.

The information will be used by the Follow-Up Division of the University Council on Teacher Education.

Your part of the study will be to check the enclosed inventory which has several questions about what you have to do on the job and what your opinion is about your school and your training. Your replies will provide necessary information for improving the pre-service training of science teachers throughout the state.

Since the information for this study can only be obtained from teachers such as yourself, it is imperative that we solicit your help.

We value your frank, honest, and prompt response and in no way do we ask you to reveal your identity.

We will appreciate your filling out and returning your blank in the enclosed self-addressed envelope as soon as possible.

Very sincerely yours,

Willard B. Spalding

Willard B. Spalding
Dean, College of Education
Executive Officer, Council
on Teacher Education

Encl.

# FOLLOW-UP DIVISION
# UNIVERSITY COUNCIL ON TEACHER EDUCATION
## COLLEGE OF EDUCATION

**Problems and Questions Concerning**
**Teachers New in the Field of High School Science Teaching**

One of the important factors in learning how we may improve the pre-service training of science teachers is to find out what the new teacher has to do on the job.

Since you are one who fits this description you can be of special help to us and we sincerely solicit your cooperation. Please answer each question as accurately as you can and return the completed questionnaire in the self-addressed stamped envelope which is enclosed.

**In no case do we wish to gain your identity so please do not sign your name.**

**Information about your school**

Number of students enrolled in your school

| less than 100 | 100-249 | 250-499 | 250-999 | 1000 and over |
|---|---|---|---|---|
| | | | | |

**Information about your training and experience**

| Undergraduate training taken at | Undergraduate major | No. of hrs. or credits in major | Undergraduate minor | No. of hrs. or credits in minor | Total no. of hrs. or credits in science |
|---|---|---|---|---|---|
| | | | | | |

The hours of credits listed above are semester hours,, quarter hours (Underline the appropriate one).

| Graduate training taken at | Major | Minor | Hrs .or credits in science | Degree(s) received |
|---|---|---|---|---|
| | | | | |

College or Univ.

The hours of credits listed above are semester hours, quarter hours (Underline the appropriate one)

Number of years of teaching experience including this year 1 2 3

Please indicate the approximate number of college hours or credits that yau have earned in the following fields:

| | | | |
|---|---|---|---|
| _____Physics | _____Chemistry | _____Practice teaching | _____Zoology |
| _____Astronomy | _____Geology | _____Botany | _____Meterology |
| _____Ecology | | _____Bacteriology | _____Biology |
| _____Agriculture | _____Home Economics | _____Physiology | _____Science survey |
| _____Mathematics | _____Curriculum | _____Engineering | _____Tests and measurements |
| _____Theories and methods of teaching | | _____Ed. Psych. | |
| | | _____Total hours or credits in the field of education | |

**Information About What You Have Done on the Job and in the Community Since Beginning Your Teaching.**

**How to fill out.**

Below are listed several duties that are often required of teachers that teach science. It is doubtful if any one teacher is required to do all of them. However, we wish for you to examine each one carefully and place a check (x) mark in the column or columns that most nearly fits your situation. It is possible that you may wish to check some of these duties in more than one of the columns that is provided for your appraisal.

| Place a check (x) mark in the columns that most nearly describe your situation. | I have done the following | I have training to do the following. | I have insufficient training to do the following |
|---|---|---|---|
| 1. Teach Chemistry | | | |
| 2. Teach Biology | | | |
| 3. Teach General Science | | | |
| 4. Teach Physics | | | |
| 5. Teach other sciences. Please specify which ones. | | | |
| _____ | | | |
| _____ | | | |
| 6. Teach subjects other than sciences. Please specify which ones. | | | |

7. Teach a survey course in science.
8. Teach an integrated program of science.
9. Plan science as a part of a core or common learnings program of the school.
10. Teach science so that students have a better understanding of present day technological society.
11. Teach students to generalize from a certain body of science content.
12. Teach students to apply scientific principles in new situations.
13. Plan the science instruction to meet the needs of your students.
14. Teach students how science can be applied to the conservation of natural and human resourses.
15. Teach the history of the particular science you are teaching.
17. Plan the science teaching so as to combat propaganda and commercial advertising.
18. Plan the science work, where possible, to contribute to the consumer knowledge of the student.
19. Teach students how the science you are teaching contributes to the health of the individual and to the community.
20. Sponsor a science club.
21. Emphasize where you can that certain leisure time activities require a knowledge of the science you are teaching.
22. Supervise and help students plan projects in science.
23. Prepare students for competitive exhibits such as Junior Academy of Science.
24. Tutor science students for special and competitive examinations (College Boards, Westinghouse, etc.)
25. Plan field trips for science classes.
26. Check on the value derived by science students from a field trip.
27. Use the resourses of the community in your science teaching.
28. Select and use audio and visual aids for science teaching.
30. Use apparatus for demonstrations which you have not used before.
31. Plan units of work in the science you are teaching.
32. Construct tests to measure the progress of your science students.
33. Evaluate the progress of your students in science.
34. Plan laboratory experiments for the science that you teach.
35. Prepare for an annual science fair in your community.
36. Repair scientific equipment.
37. Render first aid to students in your science classes.
38. Select text books, laboratory manuals, workbooks, or other teaching materials.
39. Estimate the amount of scientific equipment and material needed for the coming year.
40. Specify accurately and order the scientific equipment and materials for your science course.
41. Store properly the scientific equipment and materials of your science course when these are not in use.
42. Take inventories of the scientific equipment and materials in your department.
43. Provide for individual differences of students in your science classes.
44. Handle some unusual discipline cases.
45. Teach students how to make the best use of the library facilities of your school for the science course you are teaching.

46. Teach remedial work in mathematics and (or) reading so that the students can be more successful in your course. _____ _____ _____

47. Make out case studies of some of your students. _____ _____ _____

48. Counsel boys and girls who are in your science classes. _____ _____ _____

49. Help the students that you teach understand their abilities so that they are willing to accept themselves. _____ _____ _____

50. Teach proper boy and girl relationships. _____ _____ _____

51. Teach sex education. _____ _____ _____

52. Direct activities of home room or group of advisees. _____ _____ _____

53. Fill out various forms and records for the school office. _____ _____ _____

54. Work with other teachers in solving problems of the school. _____ _____ _____

55. Work with other teachers in planning various activities of the school program other than curricular ones. _____ _____ _____

56. Work with other teachers in your school in the study of your curriculum and possible revision of it. _____ _____ _____

57. Administer or help supervise the giving of standardized tests. _____ _____ _____

58. Interpret various diagnostic instruments that your school uses. (I.Q. tests, aptitude tests, interest tests, etc.) _____ _____ _____

59. Prepare for an open house at your school. _____ _____ _____

60. Take part in the social activities of the school. _____ _____ _____

61. Work with the young people's group in the community outside of school. _____ _____ _____

62. Serve on civic committees in your community. _____ _____ _____

63. Plan school parties. _____ _____ _____

64. Chaperon school parties. _____ _____ _____

65. Sponsor school clubs other than science clubs. _____ _____ _____

66. Take part in social activities of the community. _____ _____ _____

67. Plan a science assembly program. _____ _____ _____

68. Participate in professional organizations such as I.E.A., N.E.A. and science teacher organizations. _____ _____ _____

69. Keep up with the recent developments in the field of science. _____ _____ _____

70. Have had to answer many perplexing questions of students. _____ _____ _____

List any others not included in the above list.

_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

**What Is Your Opinion About the Professional Education of Teachers in Science?**

| Check in one column | Essential in the teacher training program. | Important but can be learned on the job. | Should be left out to give time for other training. |
|---|---|---|---|
| 1. In terms of your experience to what extent should attention be given in the study of boys and girls in relation to: | | | |
| (a) The problems boys and girls are facing or will have to face as they mature? | _____ | _____ | _____ |
| (b) The personal characteristics (understandings, attitudes, skills, etc) they will need if these problems are to be met adequately? | _____ | _____ | _____ |
| (c) The interests and needs of boys and girls at different grade levels? | _____ | _____ | _____ |
| (d) The nature of individual differences? | _____ | _____ | _____ |

(e) The problem of motivation and the methodologies suitable in achieving the goals of modern education? _____ _____ _____

2. In terms of your experience to what extent should attention be given to the analysis of community problems? _____ _____ _____

3. In terms of your experience to what extent should attention be given to teacher observation of competent teachers at work? _____ _____ _____

4. Rank the following methods of directed student teaching by placing a (1) by the method you consider the best, (2) by the method you consider the next best, and a (3) by the method you consider the least effective.

Rank

(a) Under special training teachers in training schols _____

(b) In an ordinary teaching situation in public schools under the direction of an expert teacher _____

(c) In an experimental school where recent theories of education are applied in concrete situations. _____

5. Was your student teaching program designed:

Answer yes or no

(a) To permit you to carry a complete teaching load? _____

(b) So that your students were average or above in ability? _____

(c) So that you were recognized by the students as an inferior substitute whom they must endure for a certain number of class periods? _____

| Check (x) in one column | Yes | Uncertain | No |
|---|---|---|---|
| 6. Do you feel that a student teaching program would give better preparation for teaching: | | | |
| (a) If it permitted the student teacher to carry a complete teaching load? | _____ | _____ | _____ |
| (b) If the students that the student teacher teaches range from low to high ability so that problems of adjustment will be more numerous and apparent? | _____ | _____ | _____ |
| (c) If the student teachers were permitted to take over full responsibility as a regular with little or no supervision? | _____ | _____ | _____ |
| 7. In general did you find that there was agreement in the educational points of view presented in the subject matter courses in science and the education courses offered in your teacher training school? | _____ | _____ | _____ |
| 8. Did your teacher training institution give enough work in applying educational theory in concrete situations so that you have a working knowledge of it? | _____ | _____ | _____ |
| 9. In general, should teachers be given training in conducting interesting and worthwhile science courses with little or no purchased science equipment? | _____ | _____ | _____ |
| 10. In general, do you think there should be an increased emphasis on evaluation of the outcomes of science instruction not only in terms of factual knowledge, but also in terms of understandings, attitudes, and appreciations. | _____ | _____ | _____ |
| 11. In general, do you think that teachers should be given more training in demonstration before science classes and in using different types of visual aids? | _____ | _____ | _____ |
| 12. Do you think that teachers should be required to go through a period of actual teaching (interneship) before degrees are granted by teacher training institutions? | _____ | _____ | _____ |

**What Is Your Opinion About the SubjectMatter Preparation of Science Teachers?**

| (x) Check in one column | Yes | Uncertain | No |
|---|---|---|---|
| 1. In terms of your personal experience in teaching do you think the areas of specialization in science for a teacher should be broadened so that the teacher may specialize: | _____ | _____ | _____ |
| (a) In physical science rather than physics, chemistry, geology, etc.? | _____ | _____ | _____ |
| (b) In biological science rather than botany, zoology, physiology ,etc.? | _____ | _____ | _____ |

(c) In science rather than the various branches such as chemistry, botany, physics, zoology, biology, physical science, etc.?

2. In terms of your experience, was your training in science too broad, i.e. ,would you be better prepared to do your job if you had specialized in one branch of science such as chemistry, botany, zoology, etc.?

3. In terms of your experience, were the science courses that you took on the college level broad enough in scope, i.e., did they "tie-in" with other courses of science, and with the non-science branches of knowledge?

4. In terms of your experience, should the subject matter areas give more attention to the effects of scientific achievements on society?

5. The curriculum of the present science fields was constructed largely as background foundation for the professions of engineering, medicine, and research in special fields. In terms of your experience, should the needs of teachers have recognition equal to that now awarded the other professional groups in the construction of future science curricula on the college level?

6. In terms of your experience do you think the subject-matter courses taken by prospective teachers should give concrete exemplification of the theories and philosophies of science education?

7. Should the converse of the above question obtain? That is, should the courses in the subject matter be kept distinct and apart from the educational theories and philosophies?

8. In terms of your experience, should more attention be given to "out of school" experiences, such as field trips, and less emphasis be placed on technical laboratory experiences?

9. Do your experiences support the opinion that the following values result from the present methods of specialization in teacher education in science:

   (a) Development of lifelong interests or hobbies?

   (b) Knowledge of the inter-relatedness of the sciences?

   (c) Practice in interpreting propaganda?

   (d) Practice in use of scientific method in research?

   (e) Discipline, such as habits of accuracy, open-mindedness, inquisitiveness, etc.?

   (f) Understanding the manner in which things are found out, such as scientific method, including conditions that must be fulfilled before a conclusion is substantiated, bases of scientific authority, meaning of theory and fact?

   Understanding the manner in which things are found out, such as scientific method, including conditions that must be fulfilled before a conclusion is substantiated, bases of scientific authority, meaning of theory ond fact?

10. In the space below, make any comment that you wish concerning the adequacies or inadequacies of the present day subject matter education of teachers in science.

    Do Not Pull Any Punches.

**What Is Your Opinion of The Training of a Science Teacher For Competent Participation in the Life of a Democrat Society?**

Check (x) in one column

| | Essential in the teacher training program | Important but can be learned on the job | Should be left ou to give time foi other training |
|---|---|---|---|
| 1. In looking back on your education for preparing to teach and appraising it in terms of your experience to date, to what extent should emphasis be placed on study and research related to: | | | |

(a) The growth and development of the human being from prenatal stages to maturity? _____ _____ _____

(b) Matters concerning sex adjustments, problems of sex relationships, marriage, physiology of sex, and emotional orientation in matters of sex? _____ _____ _____

(c) Matters relating to food requirements and the study of the metabolic changes in man? _____ _____ _____

(d) Public health, public health agencies, communicable diseases, (including venereal), their extent, ways of transmission, and methods of control? _____ _____ _____

(e) Mental health, analysis of factors contributing to mental disorders, and development of mental hygiene? _____ _____ _____

(f) Propaganda analysis, whether the propaganda be that of commercial advertising, of pressure groups ,or even of formalized education? _____ _____ _____

(g) Development of a coherent picture of the world and the ability to adjust the conflicts in thinking that have arisen from scientific interpretation of the nature of the world; for example, concepts of time, space, evolution, earth's position among living things? _____ _____ _____

(h) Conservation and the use of natural resources including forests, soil, minerals, water, and others? _____ _____ _____

(i) Practice in using the scientific method in solving or in dealing with practical problems and questions such as problems of consumer action, transportation, government control of resourses, etc.? _____ _____ _____

(j) Effects of science in the development of modern industrial power age, and science's responsibility in securing individual and economic adjustment in such a dynamic society? _____ _____ _____

(k) Development of such principles of ethics as are consistent with the findings of science and are workable in modern technological society? _____ _____ _____

(l) Research itself, and the understanding of the conditions that must be fulfilled before generalization may be made? _____ _____ _____

(m) Science in controversial issues such as political platforms, labor questions, and government control of resources? _____ _____ _____

(n) The nature of man, his behavior and his various cultures? _____ _____ _____

(o) Development of how knowledge of scientific facts and principles has contributed to more intelligent consumption of goods and services? _____ _____ _____

2. In terms of your experience were there "blind spots" in your science training? please list those areas which you feel are receiving little or no attention in the science curricula and which should be included because of their value in (your) personal and social life.

**What Is Your Opinion About Your School, the Science Course You Teach, and Your Success?**

Check (x) one or more

1. In your present position do you feel your science teaching is mainly directed:

(a) To prepare students for college? _____

(b) To prepare students for jobs in your community that require science training? _____

(c) To give students an undrestanding of science and how it effects our lives? _____

(d) To develop in your students the ability to reason scientifically, to hold scientific attitudes in matters outside the science field itself and to develop habits of accuracy ,openmindedness, inquisitiveness, etc.? _____

(Answer Yes or No

2. In your present teaching position do you feel that you have sufficient training and information to meet fully:

   (a) The demands of your community in your science teaching? _____

   (b) The demands of your community for community participation? _____

   (c) The demands of your department in relation to other departments of your school? _____

   (d) The demands of managing your class work? _____

   (e) The demands of fulfilling the purposes of instruction and of using various methods of teaching? _____

3. How do you appraise the curriculm of your school?

Very good_____, Good_____, Adequate_____, Needs revision_____.

4. Do you feel that you have adequate training to serve on and contribute to a curriculm revision committee or work with other teachers in setting up a common learnings program in your school in which science would play an important part? (Answer YES or NO) _____

   Do you favor such a program as stated above? (Yes or No) _____

5. In terms of your teaching experience do you feel you have been and are being: (check one)
very successful_____, moderately successful_____, not very successful_____, not at all successful_____
uncertain of success_____, in your science training?

6. Do you experience any deficiencies in training? _____

   If so, what have you needed to be more successful in teaching science?

| | Yes | Uncertain | No |
|---|---|---|---|
| 7. Do you have sufficient time to prepare for your teaching? | _____ | _____ | _____ |
| 8. Are you able to use the teaching methods which you believe to be effective? | _____ | _____ | _____ |
| 9. Does your present position offer favorable prospects for professional advancement? | _____ | _____ | _____ |
| 10. Are teachers treated by local people as members of the community? | _____ | _____ | _____ |
| 11. Are you given sufficient voice about school plans and policies that relate to your own work? | _____ | _____ | _____ |
| 12. In your school system do promotions go to staff members who deserve them? | _____ | _____ | _____ |

**Please return this inquiry to 201 Gregory Hall, University of Illinois, Urbana, Illinois.**

**COLLEGE OF EDUCATION**

UNIVERSITY OF ILLINOIS URBANA, ILLINOIS

January 20, 1951

Dear Administrator:

This letter and the accompanying inquiry form is being sent to you in order to solicit your help in making a study of what training the secondary school administrators want their beginning science teachers to have.

The information will be used by the Follow-Up-Division of the University Council on Teacher Education.

Your part of the study will be to judge and check the enclosed inventory which has a reasonably inclusive list of the possible competencies of the beginning science teacher. Your replies will provide necessary information for improving the pre-service training of science teachers throughout the state.

Since this information can best be obtained from administrators such as yourself, it is imperative that we solicit your help.

We value your frank, honest, and prompt response and depend on it for making this study.

We will appreciate your filling out and returning this inquiry form in the enclosed self-addressed envelope as soon as possible.

Very sincerely yours,

Willard B. Spalding

Willard B. Spalding
Dean, College of Education
Executive Officer, Council
on Teacher Education.

Enclosure

# FOLLOW-UP DIVISION
# UNIVERSITY COUNCIL ON TEACHER EDUCATION
## COLLEGE OF EDUCATION

### What Do You Want
### In The Training Of Science Teachers For Illinois High Schools?

**A. Purpose**

The central purpose of this study is to find out what training (competencies) the school administrators of Illinois want their beginning teachers of science to have.

This inventory has been prepared for purposes of soliciting the views of Illinois school adminstrators in this regard. It is being sent to the secondary school administrators in the state.

**B. Request**

In the main body of this inventory you will find a reasonably inclusive list of the possible competencies of the beginning science teacher. You are asked to **judge and check** the statements of competencies in accordance with the directions given below. It may be well to keep in mind while you are making your judgments that there isn't time for everything to be done in the pre-service training of a high school science teacher in the time allotted at present and some training must be of the inservice nature.

Even though only a few minutes of your time are needed to express your views, we regard your opinions as of much significance. A reply at your early convenience will be very much appreciated. A stamped return envelope is enclosed for your use.

**C. Directions**

Judge and check each competency according to this plan:

1. If the competency is one that is highly desirable, i.e., **one of the minimum essentials,** and should be included in the training program check column **2.**
2. If the competency is **important,** but not a minimum essential, and should be included in the training program **if at all possible** check column **3.**
3. If the competency is **not important and can be left out** of the training program check column **4.**

| Column 1 | Col. 2 Minimum Essential | Col. 3 Important Include If Possible | Col. 4 May Be Left Out |
|---|---|---|---|
| **I. Classroom Techniques** | | | |
| A teacher trained in: | | | |
| a) Classroom management and organization | | | |
| b) Planning units of work in his teaching field | | | |
| c) A wide range of teaching techniques | | | |
| d) Selecting audio and visual aids for his science classes and in operating the necessary machines to use them | | | |
| e) How to plan and conduct field trips | | | |
| f) Planning and performing demonstrations for science classes | | | |
| g) In construction of various kinds of tests for measuring the progress of students | | | |
| h) In directing students in how to use the library and resources of the school and community in science teaching | | | |
| i) In aiding students to select and work out various science projects in connection with the science work | | | |
| List other competencies you may wish to include | | | |
| j) | | | |
| k) | | | |
| **II. Professional Responsibilities** | | | |
| A teacher trained: | | | |
| a) In proper care and storage of scientific materials and equipment | | | |
| b) In repairing equipment and constructing simple apparatus for classroom use | | | |

| Column 1 | Col. 2 Minimum Essential | Col. 3 Important Include If Possible | Col. 4 May Be Left Out |
|---|---|---|---|
| c) In selecting, and specifying accurately, the science materials and equipment that are needed for the course he is teaching | | | |
| d) In using and explaining some of the more complex apparatus found in the science equipment (Geiger counter, pH meter, oscilloscope, etc.) | | | |
| e) In how to keep in touch with and where to find the most recent developments in the field of science | | | |
| f) So as to know the value of various professional organizations of his profession and the benefits that may be derived from affiliating with them | | | |
| List other competencies you may wish to include | | | |
| g) | | | |
| h) | | | |

**III. Application of Science To General Education**

A teacher trained:

| | | | |
|---|---|---|---|
| a) So that he can point out to students the effect of science and technological development on present day society | | | |
| b) In the scientific application of science to the conservation of natural resources | | | |
| c) In planning the science instruction to meet the real life needs of the pupils in your high school | | | |
| d) In teaching the contribution and effective use of his branch of science to personal and public health | | | |
| e) In how science can contribute to the solution of some consumer problems | | | |
| f) In how a knowledge of science can contribute to leisure time activities | | | |
| g) In the problems of marriage and family relations | | | |
| h) So as to understand that the nature of science is a method of critical inquiry | | | |
| i) In how to use the facilities of the community as a resource for teaching science | | | |
| List other competencies you may wish to include | | | |
| j) | | | |
| k) | | | |

**IV. Understanding Boys And Girls**

A teacher trained:

| | | | |
|---|---|---|---|
| a) In the physical and mental development of boys and girls of adolescent age | | | |
| b) In planning and providing for individual differences of students in the science classroom | | | |
| c) So that he knows the physical, mental, and social characteristics that effect the progress of all learners | | | |
| d) In the techniques of counseling boys and girls of high school age | | | |
| e) In psychometric techniques so as to be able to make case studies of certain students | | | |
| f) In sociometric techniques so as to be able to understand peer relationships that exist in his classes | | | |

| Column 1 | Col. 2 Minimum Essential | Col. 3 Important Include If Possible | Col. 4 May Be Left Out |
|---|---|---|---|
| g) So as to know the interests and needs of boys and girls at different grade levels | | | |
| h) In matters concerning sex adjustments of adolescents physiology of sex, and emotional orientation in matters of sex | | | |
| i) So as to know how to develop student study techniques in science | | | |
| List other competencies you may wish to include | | | |
| j) | | | |
| k) | | | |

**V. Other Aspects Of Professional Training**

A teacher trained:

| | | | |
|---|---|---|---|
| a) So as to be competent in using skills of communicating ideas (reading, writing, and spelling) | | | |
| b) So that he knows where to find and how to interpret research in the fields of education and science teaching | | | |
| c) So that he can interpret the educational statistics in educational literature | | | |
| d) In how to interpret various diagnostic instruments that the school may employ (I.Q. tests, aptitude tests, interest tests) | | | |
| e) In the problems of the high school curriculum and the place of science in it | | | |
| f) In effective ways to work with others in solving problems of the school | | | |
| g) So as to know what his responsibilities are for participating in the social and civic life of the school community | | | |
| h) In the ethics of the teaching profession | | | |
| i) So as to know the basic school laws of the state | | | |
| j) In how to attack and work out problems both personal and of the school | | | |
| k) So as to have developed a personal philosophy of education and a consistent view of the function of science teaching in the fulfillment of that philosophy | | | |
| l) So as to have developed a coherent picture of the world in order to help students adjust their conflicts in thinking that arise from the scientific interpretation of the world; for example, concepts of time, space, evolution, earth's position in the universe, man's position among the living things, etc. | | | |
| List other competencies you may wish to include | | | |
| m) | | | |
| n) | | | |

## VI. Training In The Subject Matter Of Science

**Directions**

In Column 1 below a number of different patterns which might be utilized in preparing teachers in the subject matter of science and in student teaching are listed. In Column 2 please rank each of these patterns in accordance with the following code.

Code Number

| | |
|---|---|
| 1 | Your first preference |
| 2 | Your second preference |
| 3 | Your third preference |
| 4 | Your fourth preference |
| 5 | Your fifth preference |

| Column 1 | Column 2 (Enter code number here) |
|---|---|
| **A. Pattern Of Preparation** | |
| A teacher with: | |
| 1. Intensive training in one field of science subject matter such as physics, chemistry, etc., and who has had little or no training in biology | _____ |
| 2. Sufficient training in several science subject matter fields such as physics, chemistry, biology, earth science, etc., so that he can teach more than one of the sciences | _____ |
| 3. Training spread in several science subject matter fields as in (2) and in addition much training in one field of science as in (1) | _____ |
| 4. Training in survey courses of science (physical and biological) followed by specialization in a single field of science such as physics, chemistry, etc. | _____ |
| 5. Training divided equally or nearly so in two broad fields of science such as physical science and biological science | _____ |
| **B. Pattern Of Student Teaching** | |
| A teacher trained: | |
| 1. Under special training teachers in training schools | _____ |
| 2. In an experimental set-up where the theories of modern education are applied in concrete situations | _____ |
| 3. In an ordinary teaching situation in the public schools under the direction of an expert teacher | _____ |

**VII. Your comments, criticisms, additions, etc, are sincerely invited.**

This inventory has been judged and checked by

_____
(Name)

_____
(School)

_____
(Title)

# VITA

The investigator was born on July 7, 1903, one mile from Oneida, in Knox County, Illinois. His early life was spent on the farm.

He received his elementary and secondary education in the public schools of Oneida, Illinois, and was graduated from the high school in June, 1922. He entered Knox College in the fall of 1924 and received his Bachelor of Science degree in June, 1928. He was admitted to the Graduate School of the University of Illinois in 1934 and earned his Master of Science degree in February, 1937. Since that time he has been engaged in study at the University of Illinois at various times.

He taught in the rural schools of Knox County between high school graduation and the time of entering Knox College. His first teaching assignment after college graduation was at Abingdon High School, Abingdon, Illinois, in the fall of 1928. He served as science teacher for two years, teaching botany, general science, zoology, physiology, physiography and commercial geography. In the fall of 1930 he was hired by the Board of Education of the Decatur, Illinois, schools to serve as a chemistry teacher. For the following thirteen years he taught chemistry in Decatur Senior High School, where he served as Chairman of the Science Department for four years (1939-1943) and as Assistant Principal of the high school for one year (1942-1943). He was employed by the Board of Education of Lyons Township High School, LaGrange, Illinois, as a chemistry teacher in September, 1943, and has been serving in that capacity to the present time. He has also been serving as a counselor of boys at Lyons Township High School for the past eight years.

He is a member of Kappa Delta Pi and Phi Delta Kappa.

He has served as (1) a member of the High School Committee, Division of Chemical Education, American Chemical Society, from 1940 to 1952, (2) finance chairman, South Central Division of the Illinois Education Association, 1941-1942, (3) a member of the Steering Committee, Illinois Curriculum Program, since its inception, representing the Illinois Association of Chemistry Teachers, (4) chairman of the Psychology and Education section of the Illinois State Academy of Science in 1951, and (5) chairman-elect of the Chemistry section of the Central Association of Science and Mathematics for 1953.

Papers published by the investigator include (1) "Guidance in Physical Science," published in The Science Teacher, December and February, 1937, (2) "Progressive Education and Science Teaching," published in The Science Teacher, April, 1938, and (3) "The Future of Chemistry as a Specialized Science in the High School," published in abstract in Journal of Chemical Education, March, 1941.