

COLLEGIATE COURSES ON HIGH SCHOOL SCIENCE TEACHING

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One of the most interesting features of recent progress in the preparation of secondary-school teachers of science is the development of courses in special methods of teaching the various sciences. In order that the status of such courses and also the desirable content of such courses might be learned, a brief study was made.

Science seems to have two major functions: first, to discover new ways of controlling nature so that it is possible to increase human happiness, if this word may be used; and, second, to spread the discovered knowledge so that all may benefit. Dr. Hall, the Illinois State Director of Public Health, recently pointed out that the loss of life in our state from typhoid and smallpox was tremendous, almost unbelievable as compared with many other states where the legislatures or people as a whole have been made aware of the value of vaccination and other preventive measures. In many other lines, too, the research worker is far ahead of the application of the results of his investigations. It seems that in the field of industry are to be found most of the efforts to apply new discoveries.

The purposes of this paper are: first, to show that the conditions for the dissemination of scientific knowledge are being slowly improved by better preparing teachers for work in our secondary schools; and second, to show what items supplementary to subject matter are deemed essential in the training of those teachers.

COLLEGES LISTED

The Teachers Colleges of Illinois, Colorado, and Kansas, together with Peabody Teachers College, make a total of nine state teachers colleges in this study. Eight state universities those of Illinois, Indiana, Missouri, Kansas, Michigan, Wisconsin, and Ohio, are taken as examples of their class. The Kansas State Agricultural College furnishes and other point of view. Teachers College of Columbia University and the Education Department of the University of Chicago are included.

The list thus includes 20 institutions in which courses are given in methods of teaching science. A number of conservative colleges and universities like Harvard were found to offer no work of this nature in their Liberal Arts Colleges.

There are 49 courses in methods offered by the 20 institutions studied. Of these, the teachers colleges offer 17 and the universities 19, while the other schools list the remaining 13 courses. Work in the physical sciences is three times as common as work in the biological sciences, as is shown by Table I.

TABLE I
OFFERINGS OF SPECIAL METHODS COURSES

Institutions.	Number studied	Physics	Chem.	Chem. and Phys.	Gen.	Bot.	Zool.	Biol.	Total
Teachers' Colleges.....	9	5	4	2	2	0	1	3	17
State Universities.....	8	4	4	1	4	2	0	4	19
Miscellaneous.....	3	3	1	0	7	0	1	1	13
Total.....	20	12	9	3	13	2	2	8	49

Eight courses in biology method as compared to two each in botany and zoology method reflect the present tendency to combine and offer a course in general biology in the secondary schools instead of separate courses in botany and zoology. The result of high-school demands seems to be reflected in the 13 courses in general science method, the 12 courses in physics method, the 9 in chemistry method and the 3 combination courses. These show that provision is being made for the adequate training of high-school teachers of physical science. However, the enrollment in these courses is still too small to give all the prospective teachers a sufficient knowledge of method. While about 120 take the work each year in the University of Chicago and a somewhat less number in the University of Wisconsin, there are some colleges with less than 10 taking the work each year.

HISTORY OF COURSES

As data were available on the colleges of Kansas for the past 60 years, the development of special method courses is included. The Kansas University was the only one of the 21 colleges studied in 1900 that offered a course in "*Method of Teaching Physics.*" That institution also offered methods of teaching courses in botany, zoology, and entomology. By 1910, chemistry methods had been added, and from

that time there was a steady increase in the offerings. "*Method Physics*," for instance, was offered by 8 out of 20 colleges studied in 1920, 10 of 20 in 1925, and 8 of 15 in 1930. A similar growth is found in the case of biology method which started in the decade prior to 1900, increased until 6 of the 20 colleges listed it in 1920, and 8 of 15 in 1930.

It is interesting to note that biology seemed to supplement and later supplant the earlier courses based on botany, zoology, and entomology. There is also to be noted a considerable shift of the special method work to the department of education or to the training school. With this, there was a regular increase in the number of colleges offering such general courses as "*Secondary School Methods*." Two colleges listed this work in 1910, 5 in 1920, and 13 out of 20 in 1925.

QUALIFICATIONS OF INSTRUCTORS

Of the 41 instructors studied, 14 were from state teachers colleges, 13 from state universities, and 14 from Columbia University, the University of Chicago, or the Kansas State Agriculture College. Of the state teachers college representation, 5 held the Ph. D. degree, 6 held the A. M. degree, and 3 held the M. S. degree; 10 of them were professors, 1 an assistant professor, and 3 instructors. From the universities, 6 held Ph. D., held Sc. D., 4 held A. M., and 2 held A. B. degrees. Of these, 2 were professors, 5 associate professors, 4 assistant professors, and 2 were teachers in training high schools. From the miscellaneous group, 6 held the Ph. D. degree, 5 held the M. A. degree, 2 held the M. S. degree, and 1 held the B. S. degree. Of these, 4 were professors, 3 associate professors, 2 assistant professors, 1 instructor, 4 teachers of the training high schools. These men also have from 6 to well over 25 years of teaching experience, usually including some on the secondary level.

With 18 out of 41 holding doctor's degrees and 16 ranking full professors, it appears that the work in science methods is offered by better trained men than the average college course. The instructors for these courses in both universities and teachers colleges very closely resemble each other in qualifications and experience.

PREREQUISITES

As nearly as could be ascertained, fifteen hours work in the science taught is the usual requirement, except in general science, where there is a tendency to require but ten hours of unspecified science. Five hours of

a related science and junior or senior standing are quite commonly prerequisite. In a few cases, as in the University of Chicago and the University of Illinois, actual teaching may be substituted for part of the collegiate work in the subject. Most of the teachers colleges and many of the universities in which the special method courses are offered in the education department require some work in education. About seven hours work including a course in general high-school methods is customary.

SOURCES OF DATA ON CONTENT

Materials used in the following composite portrait of the content of courses in methods of teaching secondary-school science are based on the leading books on method of teaching high-school science and on articles appearing during the past two years in *School Science and Mathematics*, or during the past year in the *Journal of Chemical Education*. From these sources, 45 items that were mentioned in connection with science method were listed and submitted to a number of outstanding college teachers of high-school science method, who kindly rated them as essential, desirable, unnecessary, or undesirable.

Those conversant with the literature of secondary-science methods will recognize some of the names in the following list, which includes only a few whose replies have been drawn upon: E. R. Downing, University of Chicago; R. K. McAlpine, University of Michigan; W. G. Bowers, University of Colorado; J. H. Walton and Ira C. Davis, University of Wisconsin; C. L. Cross and Howard W. Adams, Illinois State Normal University; E. L. Stover, Eastern Illinois Teachers College; Charles F. Valentine and W. J. Bowers, Colorado State Teachers College.

RESULTS OF QUESTIONNAIRE

Selection of Subject Matter is considered essential by 80% of those replying, and desirable by the remainder. *Aim, Function, or Values of the Subject* and *Selection and Purchase of Equipment* are almost equally recommended. *Preparation of Efficient Demonstrations* is considered essential by 70% of those reporting. *The Repair and Care of Apparatus; Use of Projective Apparatus, including Movie and Talkie; Evaluation of Texts;* and *Aim or Function of Laboratory* are considered essential by almost as large a number. *The Repair and Care of Apparatus* would probably receive a higher standing if it were not included in other science courses, as it is in the University of Chicago.

Slightly less essential are the following four items, which are considered as essential by half of those reporting: *Selection and Purchase*

of Supplies; Lesson Plans; Student's Use of Notebook, Drawings, Graphs, etc.; Laboratory Technic.

Five items which are usually given in connection with general method courses rank almost at the bottom of the list: *Dewey's Act of a Complete Thought; Supervised Study; Laws of Learning; Herbart's Five Formal Steps, and Transfer of Training.*

CONTENT OF A COURSE IN METHODS OF TEACHING HIGH SCHOOL SCIENCE

1. Selection of Subject Matter.
2. Aim, Function, or Values of Subject.
2. Selection and Purchase of Equipment.
4. Preparation of Efficient Demonstrations.
6. Use of Projecting Apparatus, including Movie and Talkie Machines.
6. Repair and Care of Apparatus.
6. Evaluation of Texts.
6. Aim or Function of Laboratory.
10. Student's Use of Note Books, Drawings, Graphs.
10. Laboratory Technic.
10. Selection and Purchase of Supplies.
10. Lesson Plans.
16. Preparation of New Apparatus.
16. Actual Teaching.
16. How to Study.
16. Use of Libraries, Bibliographies, Current Literature.
16. Relation of Subject to Other Subjects in Curriculum.
16. Standards of Good Class Work.
19. Observation of Actual Teaching.
21. Motivation and Interest.
21. Technic of Review.
21. First Aid in Laboratory.
23. Laboratory Rules.
25. Use of Excursions.
25. Making Cultures, Solutions, etc.
25. Spectacular Demonstrations.
28. Technic of Questioning.
28. Use of Objective Tests.
28. Use of Standard Tests.
32. History of Science.
32. Concept Building.
32. Ability of High School Students to Think and Respond.
32. Free Literature on Subject, Government and Manufacturer.
32. Free Demonstration Materials (incl. visual aids).
32. Organization of Science Clubs.
37. Types of Teaching.
37. Teacher's Use of Syllabi.
37. Fallacies of Science.
39. Dewey's Act of a Complete Thought.
39. Supervised Study.
41. Posters.
41. Oddities of the Subject.
43. Laws of Learning.
44. Herbart's Five Formal Steps.
45. Transfer of Training.

SUMMARY

1. From this study it is shown that most of the leading teachers' colleges and state universities are offering a number of courses on methods of teaching science in secondary schools.

2. The marked development of such courses since 1900 is shown in the colleges in Kansas, which was taken as a typical state.

3. Nearly one-half of the instructors of such courses were shown to be experienced and to hold full professorships and Ph. D. degrees.

4. Prerequisite to the courses on methods of teaching a given science was found to be sufficient work in that science itself, in related sciences, and in the field of education, to warrant the assumption that those finishing such courses would be successful science teachers.

5. The important items to be included in a course of this nature were listed, and ranked by a number of leading teachers of science method, in order that they might be made available for those who are organizing or giving such courses.