

Preparation and Certification of High School Teachers of Science: A Survey of Opinion of College Teachers of Science

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ABSTRACT

This study sought answers from college teachers of science to a number of questions concerning the present standard science certification for high school teachers. A total of 89 respondents plus 3 unusable returns plus 7 received too late to incorporate yield the following data on the opinions of the group

Are the present 30 hours of science regarded as sufficient preparation for a teacher? A slight majority favored it as an adequate preparation to teach general science but a distinct majority regarded it as inadequate to teach biology, chemistry, or physics.

Not being satisfied, what do these respondents suggest as an adequate basis in science? Each group of specialists gave between 23 and 32 hours in this field as the most frequent answer. There is a distinct difference between the biologists and the physicists and chemists in their thinking. Most of the collegians considered it feasible to increase the number of hours of science within the bachelor program.

A distinct majority favored a possible new and second certificate for the teaching of biology, physics, or chemistry, despite a significant number who were uncertain on this question. They also favored shifting the salary increment crediting advanced study from the required completion of a masters degree to a flexible non-degree program. They believed that the teachers would take more science under such an incentive and that there would be an improvement in the science teaching.

In a later report these questions will be compared with those from a companion questionnaire sent to science teachers.

INTRODUCTION

College teachers of science had¹ relatively little influence in the establishment of requirements for certification of high school teachers of science under the now applicable state regulations of the State Department of Education. More of them have exerted moderate to strong influence in the shaping of curricular programs within their own colleges. One indication of influence lies in the amount of study stipulated above the state minimum requirement.

Regardless of the history of this state of influence, private opinions of collegians frequently reflect dissatisfaction with the prevailing state and institutional requirements. This opinion usually reflects the belief that the prospective science teacher should be given more pre-service depth in science. This is a logical corollary of the philosophy that a person can only teach from the depth of his knowledge.

This present study sought to determine what the reflective opinions of the collegians are.

¹Several factors combined to account for this low participation by scientists. The problem of certification is one with which professional educators are more familiar and concerned. Few scientists have a sufficient acquaintance with school problems and practices to advance constructive help. Officers of some institutions discouraged participation by their subject matter staff. Many scientists, failing to understand the significance of the movement, were disinterested or even hostile.

THE METHOD OF APPROACH

To determine the opinions of college teachers, a questionnaire was sent in mid-February 1955 to all known teachers of science in all colleges of Oklahoma. At the end of a month, 89 useable questionnaires were returned. This represents 83% of those sent to science staff members of the University of Oklahoma, 68% of the staff members of state colleges, and 50% of the staff members of the independent colleges. No record was kept of the number sent to the members of the Oklahoma State University, this task being handled on a selective basis by a staff member of that institution.

The sample was composed of 52% biologists, 30% chemists, 15% physicists. The remaining three respondents classified themselves in other branches.

GENERAL CHARACTERISTICS OF SAMPLE:

One-third (29) of the respondents were charged with responsibility of advising teacher trainees in their colleges. The field-of-interest distribution of these advisors was slightly higher for biologists and chemists and lower for physicists. They were well distributed in the state colleges and independent groups but were under-represented at the University. These advisor-respondents were seasoned teachers with only two having less than 4 years at the present location and less than 5 years of total college teaching. However, two-fifths of the group had no high school teaching experience while another fifth had less than 4 years of high school experience.

Two-thirds of this sub-group consisting of those persons who were teacher trainee advisors had attained full professorial standing.

Of the respondents who had no continuing advising responsibilities, 14 reported high school teaching experience of one year or more. 10 of these 14 had one to three years of such experience. Six of the group were physicists and represented 46% of these specialists. In general, this sub-group with secondary level teaching experience had considerably less college level teaching experience and lower academic standing than the sub-group of advisors.

This means that two-thirds of the total respondents had no high school teaching experience.

Possibly pertinent is the number of administrators² included. There were 17 who reported spending 20% or more of their time in administrative work. The profile of distribution indicates higher than proportional representation by the chemists and very low representation by the physicists. These men were distributed among the colleges proportionately to the total sample. Their teaching experience is quite variable but only two reported having more than 3 years of high school teaching experience. All but 4 had attained full professorship and 10 reported teacher trainee advisement responsibility.

Only 7 respondents reported more than 2 years of college level experience in fields other than their present ones. All of these persons were physical scientists who had extensive college level experience. Six were located in state colleges and have had secondary school teaching experience and now have teacher advisement experience.

This constitutes the sample of scientists whose opinions are reported here.

HOW MANY HOURS OF SCIENCE DOES A SCIENCE TEACHER NEED TO PREPARE TO TEACH GENERAL SCIENCE?

Question 1 asked "Do you consider the certification requirements of 30 hours (distributed in all fields of science) adequate for training a teacher for general science, or biology, or chemistry, or physics?"

² In this classification, "administrator" includes heads or chairmen of science departments as well as academic deans.

Considering part (a) General Science, first, the respondents, grouped according to field of interest, replied on a "yes" to "no" ratio as follows: Biologists 1.6, chemists 1.25, physicists 2.25, all 1.6. In this the chemists were more uncertain than the others although that uncertainty was distributed evenly among the colleges. Except for these chemists there were too few others undecided to affect the order of magnitude of the ratio.

The answers grouped according to the college grouping showed a "Y:N" ratio of 3.0 for the independent colleges, 2.28 for the state colleges, 0.5 for Oklahoma State University, and 1.75 for the University. This is rather interesting in that the collegians who consider 30 hours enough for general science teaching are in colleges where there is comparatively little research activity. The sub-group that felt that more science was needed to prepare for general science represent the two large schools where research is a major activity. It may be assumed that personal involvement in the research function influences the attitude of the college teachers.

Question 6 was stated as follows "How many credit hours of each science taken in content courses do you consider needed to prepare a teacher properly?" In the case of general science, the respondents were asked to count all of the science taken in any of the recognized fields. Table I gives the data in terms of percent-of-respondents in each class:

TABLE I
COLLEGE HOURS OF SCIENCE BELIEVED NEEDED TO PREPARE
A TEACHER TO TEACH GENERAL SCIENCE

Data in Percent of each group that responded according to field.

Hrs.	Biol.	Chem.	Phys.	All	Indep.	S.C.	OS	OU
30	40	23	31	33	56	40	10	30
40	20	15	7	16	22	18	20	14
50	11	11	0	8	0	10	30	8
No opinion	11	27	46	22	11	10	20	31

Biologists called for more science courses than did chemists or physicists. Chemists and physicists were much less certain how many hours were desirable. University scientists had more "no opinions" than any of the other groups. The A and M personnel favor more science. Only the independent colleges seem to be satisfied, with very little science.

HOW MANY HOURS DOES A TEACHER NEED TO PREPARE TO
TEACH A SPECIALIZED SCIENCE

Going from general science to the specialized sciences (i. e. biology, chemistry, or physics) in other parts of Question 1 there was much less uncertainty and more definite opinions. Less than 10% of the respondents believed the 30 hours distributed in the present requirements sufficient science for a teacher of any one of these three specialized sciences. Where substantial uncertainty exists it is concentrated among the chemists at A and M and OU. At least 70 of the 89 respondents checked "no" on this question (Q1) of adequacy for each of the three sciences.

It is interesting to see whether these scientists can define their own concepts of standards in terms of hours of preparation in science. In question 6 the opportunity was given to stipulate how many hours in a particular science a teacher trainee should take in order to be prepared to teach at the high school level. Table II contains these data in terms of per-cent-of-group responding.

TABLE II

COLLEGE HOURS OF SCIENCE BELIEVED NEEDED TO
PREPARE A TEACHER TO TEACH SPECIALIZED SCIENCE

Data in percent of each group of respondents.

Hours	ACCORDING TO FIELD			ACCORDING TO TYPE OF INSTITUTION				
	Biologists	Chemists	Physicists	All	Indep.	S.C.	AM	OU
A. Biology								
22 and under	22	31	46	26	33	23	10	40
23-32	40	23	23	45	22	50	20	38
33 and over	35	11	0	21	11	21	60	9
unanswered	0	31	30	14	33	7	10	16

Hours	ACCORDING TO FIELD			ACCORDING TO TYPE OF INSTITUTION				
	Biologists	Chemists	Physicists	All	Indep.	S.C.	AM	OU
B. Chemistry								
22 and under	52	35	46	45	55	43	40	42
23-32	20	42	39	31	11	43	20	40
33 and over	16	7	7	11	11	14	40	8
unanswered	6	11	7	10	22	0	0	16

Hours	ACCORDING TO FIELD			ACCORDING TO TYPE OF INSTITUTION				
	Biologists	Chemists	Physicists	All	Indep.	S.C.	AM	OU
C. Physics								
22 and under	51	46	46	50	55	57	40	44
23-32	20	35	39	25	11	15	20	37
33 and over	14	7	7	10	11	14	30	8
unanswered	14	19	7	14	22	4	10	16

Except for the physicists each group of specialists wanted 23 to 32 hours in its field, judged by the checking by 40% of the sub-group. Biologists thought a teacher needs more chemistry to teach chemistry than physics to prepare to teach physics. Biologists also considered it takes much more study in biology to prepare for biology than it takes in chemistry or physics, possibly based upon the claim that there are two fields to cover in biology (namely botany and zoology.) Biologists seemed to have more definite opinions about the other fields than did chemists and physicists about biology.

Chemists rate the need for study in biology low and for study of physics high. In fact, they are inclined to require as much physics as chemistry to teach chemistry.

The physicists rated chemistry as needing as much preparation as physics, but they lacked very concrete ideas about biology.

Classified according to type of colleges, the respondents from the University were fairly consistent in their requirement for all sciences. In a much smaller sample the A and M respondents called for more science than did their OU Colleagues. State College personnel favored more biology for biology teachers, a fair amount of chemistry for chemistry teachers, but much lower amounts for the physics teachers. This probably reflected the weaker position of physics in the state colleges.

While calling the present 30 hours too low as a standard of preparation, only one-third of the chemists and one-fourth of the physicists would require more than the 22 hours in biology for teaching biology. Yet approx. one-third of the biologists called for more than 22 hours in chemistry or physics. This reflects the point that each specialist knows his own field and favors it.

CAN THE NUMBER OF HOURS OF SCIENCE IN THE UNDER-GRADUATE YEARS BE INCREASED?

Question 4 asked "Do you consider it feasible to increase the hours of science required in the state certificate (standard) in the first 124 hours of study." The data have been tabulated in Table III according to per cent of each group responding.

TABLE III
FEASIBILITY OF INCREASING HOURS OF SCIENCE IN BACHELOR'S DEGREE PROGRAM

Data in percent of each group that responded.

Answer								
Yes	66	57	70	64	44	78	70	55
No	16	19	7	15	22	11	30	8
Undecided	9	23	23	17	22	11	0	13
Unanswered	4	0	0	0	11	0	0	16

Specialists in all fields favored an increase in hours in the first 124 by very substantial majorities. The greatest amount of indecision exists among the chemists and physicists. Objection to increase seems to be concentrated in the independent colleges, four of which already require 36 or more hours of science in their programs. The state colleges and A and M favored increase by the widest margins.

Question 5 applied only to the "yes" answers to question 4. Question 5 asked whether that increase should be applied to each of the sciences. Again in this case general science differed from the other specialized sciences. Approximately twice as many individuals would not apply any increase in science hours for teachers training for general science. The possibility exists that this part of the question could be interpreted in either of two ways: first, the respondent might have considered that an increase in science hours should be applied to college general science courses for preparation for teaching in high schools, or second, the question might have been interpreted as applying the increase to specialized college courses in order to prepare for teaching general science in high school. It is conceivable that the college specialist does not understand the problems of teaching general science in high school clearly enough.

When it came to the question of the increase in required science hours being applied to teachers preparing to teaching one of the specialized sciences the collegians overwhelmingly favored by that increase by 47 to 5. This applied quite uniformly to all fields of specialization and to all college groups.

A POSSIBLE NEW CERTIFICATE

Question 8 asked "Do you favor establishing an additional standard certificate to teach biology, or physics, or chemistry?" "Yes" answers were in decided majority. The ratio of "yes" to "no" answers exceeded 5 to 1 for all combinations except chemists and physicists passing judgment upon biology. The ratios were the same for the types of colleges except for the independents. More persons were uncertain than negative with ratios of

"yes" to "undecided" ranging between 2 to 1 and 3 to 1 for practically all sub-groups. The affirmative answers were numerous enough to show a preference that a new certificate be established. However, the question did not indicate how many hours in the specialty would be required so that it cannot be construed as a concrete proposal.

Since raising science requirements for an additional certificate could conceivably introduce problems of increased personnel and equipment, question 9 was framed as follows: "Would such a new certificate, presumably based on the number of hours given in (Q6) require an otherwise unjustified increase in personnel and equipment in your department to provide the needed courses of instruction". Eight respondents answered "yes"; 5 of these were in state colleges, 6 were chemists. In addition, 18 checked undecided, 5 being in state colleges, 8 at the University, 8 were chemists, and 9 biologists. The 51 negative answers was almost double the sum total of "yes" and "undecided." It may be assumed that a raise in certificate requirements would not introduce a major increase in personnel and equipment that would not otherwise be warranted by increased enrollments.

Another consideration involved in a new certificate assumed that any increase in science courses might occur after the bachelors degree. At present, the only mechanism available to the teacher to qualify for the \$200 increment under the standard salary pay scale is to take a master's degree. Question 10 asks "Do you favor permitting course requirements above the present 30 hours required for a possible new and second certificate in biology, chemistry, or physics to be obtained in a fifth year non-degree program?" Those answering "yes" were approximately four times the number that answered "no", and three times the number answering "uncertain." Over 60% answered affirmatively to this question. It should be noted that the question itself implied but did not stipulate that a fifth year-non-degree program was to be substituted for the masters degree.

This question of the change of basis for rewarding teachers was taken up in question 16 which read "Would a change in the basis for earning the salary increment from a masters degree to completion of 30 to 32 hours of course work beyond the present standard certification based upon a bachelors degree encourage more science teachers to take more courses in science?" This question really asked an opinion on belief in teachers' practice in enrolling in science courses. It is not necessarily a question of whether they favor a change. Over 60% believed that this incentive would result in teachers taking more science. There were only 10% who did not believe that such a change in practice would follow. The others were uncertain with perhaps a larger number concentrated in the state colleges and A and M sub-groups.

SHOULD A MAXIMUM ON METHODS COURSES IN TEACHING OF SCIENCE BE PUT INTO ANY NEW CERTIFICATION REQUIREMENT?

Two-thirds of the respondents believed there should be such a maximum. Only in the state colleges and A and M sub-groups was there any even division of opinion. In these two groups the number of "no" and "undecided" answers were about even and their sum equalled the number checking "yes".

The corollary question asked how many hours should constitute that maximum. Approximately 50% of the respondents stipulated there should be fewer than 5 hours while approximately 37% specified from 5 to 10 hours as the maximum. The remainder of the group that favored over 10 hours included several large figures that must be questioned whether the respondents were thinking of all methods courses or only methods courses in the teaching of science.

QUESTION 14

This question proved to call for a double answer. It read: "Do you (know, believe) whether this basis acts as an incentive for science teachers to take more science courses?" The basis referred to was that of rewarding teachers on completion of their masters degree. The first part of the question sought to distinguish knowledge and belief. A total of 26 checked one or the other. The number checking "yes" that the degree was a basis for an incentive was 10. It was less than the 15 who knew or believed that it was not an incentive to take more science courses. There is much more uncertainty among the people who did not check either the know or believe part. The response ran 10 for "yes" incentive, 23 for "no" incentive, and 24 undecided. As a group the biologists were more uncertain than the chemists or physicists.

It is now doubtful whether this is a clear-cut question which can yield a clear-cut answer. It is apparent that more people regard a masters degree alone, considering the inability to work off a masters degree in a science field, as no particular incentive for a teacher to improve himself by taking more science courses.

A somewhat better insight is given in question 15 which asked, "Do you find that the prerequisites for graduate standing set by the departments before credit for course work counts for a masters degree deter many science teachers from taking content courses that would be beneficial to their work." This is a question that is frequently discussed among the faculties of Oklahoma A and M College and the University. Table IV gives the distribution of responses according to percentage of respondents in a particular sub-group:

TABLE IV
EFFECT OF GRADUATE STANDARDS AS DETERENTS TO ENROLLMENT IN SCIENCE ACCORDING TO FIELD DATA IN PERCENT OF EACH GROUP THAT RESPONDED.

ACCORDING TO FIELD Answer						TYPE OF INSTITUTION		
	Biologists	Chemists	Physicists	All	Indep.	S. C.	AM	OU
Yes	61	57	70	63	77	40	60	80
No	18	11	7	14	11	32	0	3
Undecided	18	14	14	17	11	18	40	11

A distinct majority in all fields believe that this situation of prerequisites acts as a barrier to science teachers studying science at the graduate level. Only the personnel in the state colleges as a sub-group did not concur in the substantial majorities indicated by the other sub-groups. It should be noted that there is a very distinct difference between college personnel and the scientists at Okla. A. and M. College and the University in the definition of a science major.

OPINION ON ALTERNATE INCENTIVE PLAN.

Question 16 has been mentioned previously together with Q. 17 and Q. 18, it covered a question of effect in changing the reward for graduate study from a masters degree requirement to completion of 30 to 32 hours beyond the present certificate. In effect this means that the salary increment could be paid to teachers who are taking underclass courses to round out their background.

Question 16 asked whether the respondents believed that science teachers would take more science after a change in the basis of awarding the salary increments. While one person in 4 was undecided on this question, the others were definitely of an opinion that science teachers would take more science. This ratio ran from 1.5 to 1 for a group of physicists to 3.5 to 1 for a group of biologists. The greatest degree of indecision was among the state college people, a small sample of Oklahoma A and M people, and the biologists.

Question 17 asked "Do you believe that an improvement in the teaching of science in the secondary level would result from such a change mentioned in the previous question?" The distribution of answers is quite similar to that of the previous question, except that the respondents were more positive. The greatest uncertainty was again found in the state college sub-groups.

Question 18 asked whether they favored such a change on the basis of earning a salary increment. The distribution was quite similar to that of question 17. It is especially significant that there is a predominant favoring by the University personnel who are more traditionally dedicated to the depth theory of graduate study.

In this trio of related questions a total of 47 persons answered "yes" to all three.

CONCLUSIONS

College level teachers of science definitely favor more instruction in the sciences in teacher training programs. This applies to their conception of specialized science courses in senior high school more than to the generalized science instruction at the junior high level.

Collegians most frequently think in terms of 23 to 30 hours study in a particular college level science as giving the necessary foundation for the high school teaching of that subject. Collegians would favor such an increase. However, this support is not apt to be militant, in view of the time lapse between gathering of opinion and preparing this report. The author has heard of no concerted action along these lines in the interim.

Collegians are inclined to accept a fifth-year non-degree program as the basis for increased compensation, believing that it would increase interest in and effectiveness of teaching science if the present masters degree requirement were so modified. This represents an advancement in recognition of reality on the part of the collegians, although it is probably belatedly acquired.

Data have been gathered from a sample of teachers on many of the same questions but the comparison of their opinions with those of the collegians has yet to be made.

61 Faculty Exchange
Norman, Oklahoma
February 15, 1955

Dear

I am asking for this information primarily for my own guidance in my activities on the Oklahoma Commission on Teacher Education and Certification. The responses will be considered as the research analysis underlying any synthesis of a program I may attempt to introduce. Publication of results may or may not eventuate, although we may assume that all reasonable effort will be made to conceal the identity of individual respondents. It may also be assumed that the writer believes that some way must be found to increase the subject matter content backgrounds of Oklahoma science teachers of the secondary level.

I have two fixed dates at which this information will be most helpful to me; March 25, at a Discussion Session on "Improving the Quality of Teaching Through More Realistic College Programs and Certification Requirements for Science Teachers" at the convention of the National Science Teachers Association; and April 14, at the next meeting of The Oklahoma Commission. Consequently, an early return of this questionnaire will be appreciated.

8. Do you favor establishing an additional standard certificate to teach:

Yes No Undecided

- a. Biology _____ _____ _____
- b. Chemistry _____ _____ _____
- c. Physics _____ _____ _____

9. Would such a new certificate, presumably based upon the number of hours given in (6), require an otherwise unjustified increase in personnel and equipment in your department to provide the needed course instruction:

Yes _____ No _____ Undecided _____

Comment: _____

10. Do you favor permitting course requirements above the present 30 hours required for a possible second and new certificate in Biology, Chemistry, or Physics to be obtained in a fifth year non-degree program:

Yes _____ No _____ Undecided _____

11. In your college's program, could that extra work normally be obtained in one or two summer sessions:

Yes _____ No _____ Undecided _____

12. Do you believe that any maximum limit on hours taken in methods courses devoted to the teaching of science should be incorporated in any new certificate to teach a specific science:

Yes _____ No _____ Undecided _____

13. If the answer to (12) is "Yes", please state how many credit hours you believe that maximum should be _____.

ATTITUDE TOWARD ADVANCED DEGREES FOR TEACHERS

At present, the basis for rewarding teachers for advanced study (\$200 increment on standard scale) is completion of a master's degree.

14. Do you (know, believe) whether this basis acts as an incentive for science teachers to take more science courses:

Yes _____ No _____ Undecided _____

15. Do you find that the prerequisites for graduate standing set by science departments before credit for course work counts toward a Master's Degree deter many science teachers from taking content courses that would be beneficial to their work:

Yes _____ No _____ Undecided _____

16. Would a change in the basis for earning that salary increment from a Master's degree to completion of 30 to 32 hours of course work beyond the present standard certification based upon a bachelor's degree encourage more science teachers to take more courses in science:

Yes _____ No _____ Undecided _____

17. Do you believe that an improvement in the teaching of science at the secondary level would result from such a change mentioned in (16):

Yes _____ No _____ Undecided _____

18. Do you favor such a change (16) in basis for earning the salary increment:

Yes _____ No _____ Undecided _____

INFORMATION NEEDED FROM THE RESPONDENT

This survey is addressed to all known full-time teachers of science (Botany, Chemistry, Physics, Zoology) in the Oklahoma colleges which have approved training programs for science teachers. Each respondent is asked to answer on the basis of personal conviction, rather than as an official of his institution.

To protect the privacy of the individual, this last sheet will be detached from the rest of the reply after a code number has been assigned. You have my assurance that your identity will not be revealed except on your written permission.

There is no objection to your discussing this matter with your colleagues but you are asked to prepare your answers independently on the basis of your own convictions.

Data concerning respondents will be released only in these categories:

Present Field of Science: Biology _____ Chemistry _____
Physics _____ Others (Specify) _____

Other fields of science with more than two years of college teaching experience _____

Type of college: Independent Colleges _____ State Colleges _____

(Check one) Oklahoma A & M _____ University of Oklahoma _____

Years of Full-time Teaching at Present Location: 3 or less _____

(Count through June 1957) 4-8 _____

9-15 _____

16-or more _____

Total years of Full Time Teaching at College Level: 5 or less _____

6-10 _____

11-20 _____

21 or more _____

Teaching Science at Secondary Level:

Number Years Experience _____

Year of Last Experience _____

Field(s) of Science _____

Present Academic Rank _____

Proportion of Time Spent on Official and Administrative Duties _____

(Exclude student advisement and direction of department)

Do you have any fixed and continuing responsibility for academic advising science teacher trainees: Yes _____ No _____

Signature