SECTION E, SCIENCE EDUCATION

Subject Matter Preparation of Some Oklahoma Teachers of Chemistry and Physics

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This paper deals with 123 Oklahoma teachers of chemistry and physics. The sample is not necessarily representative, but it is extensive and the pertinent data have been accessible and readily analyzed. The data are taken by transcription from 9C-24B application forms to various NSF-supported 1959 Summer Institutes with the cooperation of directors (See Appendix II). All institutes to which an estimated number of 3 Oklahoma teachers might be applying were so addressed. The transcriptions also include pertinent data for biology, general science and mathematics teachers, but no analysis of those characteristics has been started.

The validity of the data is believed high, but not necessarily uniformly accurate. Major sources of inaccuracy lie in the accuracy of the applicants in filling out the 9C-24B form and in the clerical transcriptions. All data are as of January-March 1959.

Data requested include: name, school, age, years experience in each pertinent subject, teaching assignment, hours of preparation in pertinent subject (both undergraduate and graduate), degrees, and choice of institute courses preferred to be studied. A copy of the transcription sheet is attached in Appendix I.

Information added has been an estimate of school enrollment based on the number of secondary school teachers listed in the 1958-59 Oklahoma Educational Directory (1) and multiplied by 25 as the teacher:student ratio. In cases where a single school spanned 7th to 12th grades, one half of the staff was considered to be in the senior high school.

Characteristics of the Sample

Sixty teachers taught chemistry, but not physics. Twenty more taught chemistry and physics. Forty-two taught physics, but not chemistry. Nine teachers had four or five classes of chemistry and/or physics and can be considered chemistry teachers or physics teachers by virtue of having a major responsibility for one of these two subjects. Thirty-four others taught two or three classes in at least one of these subjects and may be considered having approximately half of their responsibility concentrated in these fields . The remainder teach only one class and must be considered incidental teachers, either in small schools or as assigned for administrative convenience. This latter group can be expected to experience considerable competition from other subjects and duties that interfere more with pursuit of scholarly interests than will the first two groups whose work requires—and permits—the teacher to devote more adequate attention to the state of his own understandings in the subject matter.

Twelve of this sample were women, seven teaching chemistry but no physics, one teaching chemistry and physics and four teaching physics but not chemistry. Nine of the women had less than five years of teaching experience in the particular subject, four with as little as two years. Only four of the women reported ages under forty, indicating a number had been converted from other subjects under the stress of teacher supply.

Only one woman had a full-time chemistry schedule while eight had only one class in either chemistry or physics.

This sample is well represented by young teachers with eleven under 25 years of age, 33 under 30, 56 under 35. The age bracket 36-45 had only 25 members, against 21 who were 46 or older.

Contrasting with this age distribution were the years of teaching experience in the subject. A total of 75 had only one to three years of teaching the subject. Twenty more had four to six years experience. This makes the sample one of relatively limited experience, indicating a terrific turnover in personnel, a fairly high proportion of teachers converted from other fields, and a possible effect of public opinion forcing schools to offer these two subjects. At least problems of personnel are reflected. Fortunately, the proportion of teachers teaching both chemistry and physics runs more to the experienced side, with nine out of twenty having seven or more years experience in one of the two subjects.

By degree preparation, 58 of the sample are teachings on bachelors or first degrees. This is not surprising considering the age distribution of the sample and the number of women. Fifty-seven hold masters degrees, with about two-thirds of them in the Master of Education or related category against one-third in the M.N.S. or M.S. group based more on the subject matter content courses. Of the latter third, seven are teaching the two sciences, six teaching chemistry and five teaching physics. Of those thirteen teaching chemistry, either with or without physics, only four report more than 40 hours in the subject and all four are teaching in either Tulsa or Oklahoma City. However, in the training of a professional chemist, forty hours in the field is considered the minimum requirement for an accredited undergraduate program. Three of these "subject-matter masters" are teaching chemistry on less than 20 hours of personal study in the subject although their degree is not necessarily taken in chemistry. In the case of the teachers of physics, only two exceed twenty hours personal study in physics . Nine of the other ten range from 11 to 20 credit hours preparation. This indicates that so far as personal study is concerned, these teachers had little opportunity and/or encouragement to bolster their own backgrounds to a more understanding level.

Teaching of chemistry and/or physics is not necessarily confined to problems of teacher preparation. However, the interest of well prepared teachers can be expected to be influenced by the opportunity to make good use of their educational preparation. The largest factor operating in this respect is probably the size of the school. It was most convenient to take the size of teaching staff reported from the individual schools and multiply by 25 as representing the student:teacher ratio to obtain the enrollment. The results are given in Table I:

TABLE I

SIZE OF SCHOOL (PUPIL ENROLLMENT) IN TERMS OF TEACHERS TEACHING

ENROLL.	CHEMISTRY	CHEM. & PHYSICS	PHYSICS	TOTAL %
150 & under	8	2	15	25
150-300	19	6	8	33
301-500	11	4	2	17
501-1000	5	3	6	14
1001 & Over	8	1	3	12

It should be kept in mind that several teachers applied to institutes from single schools.

Several questions can be raised by the data in Table I. Why is the offering of physics in the smallest schools so disproportionately higher than the offering of chemistry especially since the mathematical preparation for physics is so much higher? Analysis of the mathematical backgrounds of these fifteen teachers of physics in very small schools shows only two with less than twenty hours of credit, indicating many had taken programs leading to certification in mathematics. Or a partial answer may lie in physics being a better "text, non-lab" course than chemistry, with demonstrations being more manageable and effective. Some allowance must be made for the practice of offering chemistry and physics in alternate years.

Combination assignment of physics and chemistry seems to be given in school sizes of 150-500 most frequently, indicating a possible and convenient solution to teaching combinations for administrators.

The larger schools indicate assignment full or almost -full time to one or the other specialized subject, of course, with or without other fields used to round out a teaching schedule. This latter practice is to be expected where larger staffs permit specialization.

Such are the characteristics of the sample that can be grouped together statistically and independently. The next sections deal with numbers qualified according to different standards of preparation, the characteristics of those not qualified, the qualifications for teachers for the newly evolving curricular course in ninth grade physical science, institute planning for the upgrading of teacher preparation, and the limitations of this study as the basis for action planning.

STANDARDS OF QUALIFICATIONS

Oklahoma school law follows North Central Association rather closely in these matters. The standard certificate (five years, renewable) requires 30 hours (minimum) in science to teach science as the major field, ten hours in chemistry to teach chemistry and ten hours in physics to teach physics. These are educator definitions, generally influenced by a compromise of teacher-training directors and administrators.

Opposed to this level of requirements is the instinctive reaction of the professional scientists who reason from a position of understanding the subject matter well as paramount. Educator standards generally appall the scientist.

That some sort of middle ground must be found is implied in the TEPS programs and conferences and in the North Central considerations now in progress. Indications point to the probable increase in number of hours required for teaching in a second field, not necessarily in a specialized field like chemistry or physics.

In this particular sample of Oklahoma teachers, using 24 credit hours in chemistry as well-prepared basis and 15 hours as a more realistic minimum (than 10), twenty-eight now teaching chemistry, plus five more not now teaching the subject, are qualified on the 24-hour basis. Thirty-two now teaching would qualify on a 15-hour basis.

Similar figures for the teachers of physics would be based on 20 hours in physics as the desirable goal with 15 as the more (than 10) realistic minimum. In this sample, nine out of the present sixty-three would meet the desired goal while twenty-two would meet the 15-hour minimum.

THE LESS THAN QUALIFIED

Taking the existing State Department-North Central minima of 10 hours to teach in a field, nine in this sample (11%) are teaching chemistry with less than minimum requirements while thirteen (20%) are teaching physics with substandard preparation. Lest these figures be taken out of context, it should be kept in mind: (1) this is no new discovery, (2) it is a long-time problem confronting administration and state inspection, (3) it includes a number of teachers underprepared in one subject but well enough prepared in one or both of the most cognate subjects—mathematics and the other physical science. Nevertheless, the author is unwilling to let this matter go unnoticed. Programs exist, or can be developed, to bring these individuals up to a more desirable level of background information. This aspect is treated in a later section.

Of the 10 chemistry teachers having less than 10 hours of preparation, only 3 have more than 20 hours chemistry *and* physics credit, four have more than a total of 30 hours, chemistry, physics and mathematics. Five teach in very small schools with enrollment less than 150, three more in schools in the 150-300 range.

Of eight teachers teaching chemistry *and* physics only one falls below 23 hours total in these subjects. The curse of poor preparation is partially offset by the combined chemistry-physics-mathematics totals ranging from 35 to 65 for six of these eight. Five of this sub-sample teach in schools of 150-300 enrollment; none in the below-150 schools, reflecting the practice of teaching the two sciences in alternate years.

When it comes to the five teachers of physics (but not chemistry), only one has as much as 21 hours of chemistry and physics and only two have enough more mathematics to give them a good grounding for teaching. Four of the five teach in schools under 300 enrollment.

To the author, it is much more reprehensible that we remain satisfied with a 10 hours definition of adequacy. There is a complex of dovetailing problems that does not permit a drastic and immediate change to the level of scientist-thinking. Teacher-supply is simply one of the larger roadblocks to be resolved. But it seems perfectly reasonable to move soon to a position of 15 hours minimum, permitting an adequate study of organic chemistry as well as inorganic, of modern or particle physics as well as classical. Since some of our institutions are doing this in pre-service programs, the author wishes to confine his discussion to the teachers already permitted to teach.

The author is not altogether happy with a 15-credit-hour minimum. He believes that the 24 hours in chemistry and 20 hours in physics is a more desirable goal toward which to encourage teachers to move in their graduate or fifth year programming. But this present section is devoted to those in this sample as they are compared with the 15-hour minimum.

This sample shows 30 teachers now teaching chemistry but not physics, 16 more now teaching chemistry and physics, and 22 teaching physics but not chemistry and who hold less than 15 hours credit in the subject they teach. Of the chemistry teachers, there is only one with more than 30 hours in both chemistry and physics and who is teaching chemistry, but 12 exceeding 30 credit hours who are also teaching physics. Of the physics teachers, ten could have been collegiate mathematics majors. This is increased by three in the chemistry-physics teaching category.

On an 18-hour requirement basis, the above figures would be increased to 36 teaching chemistry, 18 teaching chemistry and physics, and

30 teaching physics and who would fall short of this level of requirements.

Raising the minimum requirements for certification from 10 to 15 or 18 hours in either chemistry and physics would certainly catch many Oklahoma teachers with necessity of studying their subject matter more closely.

Teachers for Ninth Grade Physical Science

In a sub-committee of the Oklahoma Curriculum Commission a comprehensive report is nearing completion. It will recommend that science in the ninth grade be devoted to physical science, with most emphasis on chemistry and physics. This course is intended to (1) introduce enough chemistry and physics from an energy, structure, and principles point of view to permit more teaching of tenth-grade biology from the dynamic viewpoint, (2) expose the non-college-bound student to some basic chemistry and physics that he now escapes, (3) to permit teaching chemistry at the tenth grade and physics at the eleventh grade to more competent students (or to those in accelerated programs) from a more rigorous point of view. In order for this transition to occur over the period of the next five years, many teachers must be updated and many more must be re-trained. This sample is now being studied to determine how this brood of teachers must compare to new standards.

An arbitrary set of qualifications is now proposed as a starting point; 50 credit hours in chemistry, physics and mathematics combined, with at least 10 hours in each of those fields. Astronomy and meterology may be substituted up to six hours each in the uncommitted block of 20 hours. It is assumed that these teachers will generally be well along toward completing their master's degree so that this total of 50 hours is on a basis of 150-160 hours, rather than on 120-125.

In checking the teachers of this sample against these qualifications, it is evident that 31 are now well enough grounded, subject matterwise, to handle physical science.

Another group could come up to the proposed standards with six or fewer hours in a single field, three or fewer hours in each of two fields, and not more than 8 hours in all three fields. Altogether, there are forty additional teachers who could be brought up to standards. Only five of them need study in two fields. Physics is needed most—19, with chemistry a close second with 17.

This does not mean that all teachers of the sample could be brought up to new standards, but it does mean that 71, or over half of the total sample, could well and easily be brought up to qualification for the new teaching job to be done.

No estimate can be made of the problem facing the many more teachers handling present day general science. The problem of upgrading, presumably, would be tremendous. But it is most logical that the persons with experience in the separate sciences would be the most mobile group to upgrade and re-train to nucleate the next job. The ninth grade physical science could fit into teaching combinations much more to the advantage of teacher background and presumed area of interest, much more logically than a mixed earth-biological science background now prevalent in the ninth grade general science teacher. This latter group would be better equipped to handle seventh and eighth grade science.

The Use of Institutes

With the availability of summer and in-service institute programs

under NSF support, implementing the foregoing described goal of updating is feasible and reasonable. Two particular levels of institutes are needed, the grossly remedial for the heavily under-qualified (where concentration on a single branch would be possible) and the advanced for the above average and experienced teacher. However, no one institution can do the job alone. If a logical and orderly step forward is to be made, it is up to the institutions of Oklahoma to establish a meeting of the minds and develop a joint program in which the talents and facilities of each can be used to best advantage.

Limitations of This Study

Data cited and interpreted have been based on 123 teachers who applied to summer institutes, somewhere, in 1959. The data, except school size, are limited to that given in the NSF application form 9C-24B, furnished originally by the individual and transcribed by cooperating institute directors.

There are perhaps 175 teachers of chemistry and 150 teaching physics in Oklahoma, with perhaps 40 teaching both subjects. This means the sample covered approximately one-third to one-half of the teachers of these subjects. How representative such a sample is, there is no way of telling. It can not be made to tell anything about relative teaching ability or attitude. Nor does the fact of applying for an institute indicate that the teachers in the sample are necessarily more scholarly or more competent than those in the non-sample. The author has had more than a casual acquaintance with about 30 in the sample. He has no way of rating them except on their responses to different situations and events. He is inclined to regard teachers in this sample as being considerably above the non-included teachers in alertness to their own needs for study and in initiative in doing something about it.

Despite the limitations on this sample, the data are submitted in tentative form in the hope that the implications receive attention. What facts are stated as facts are facts. They give some support to criticisms, but they are more valuable for the possible basis for corrective action that must occur before some of these major problems in science education are resolved.

Literature Cited

1. Oklahoma Educational Directory, 1958-1959. Bulletin 100-4. Issued by Oliver Hodge, State Superintendent, Oklahoma City.

Appendix I

SURVEY OF OKLAHOMANS APPLYING TO NSF SUMMER INSTITUTES, 1959.
To The Cooperator:

Follow the NSF form 9C-24B numbering, as these same numbers are retained in this transcription. Use one sheet per application. Confine your record transcriptions to applications showing a school address in Oklahoma. Eventually return forms to H. H. Bliss, 61 Faculty Exchange, University of Oklahoma, Norman, Oklahoma.

1. Mr. Mrs. Miss _____
(last) (first) (middle)

3. Name of school_____ Hi_____ Jr. Hi_____ 8. Age_____

14.a. H.S. experience_____years, from_____to_____

15. Science and mathematics 16. Present assignment: 17. Education:

teaching experience:				Year	Degree	Major
Subject	Yrs.					
GS, 7					AB, BS, BEd	
GS, 8					MS, MNS, MEd	
GS, 9					or other Masters	
Biol.					Other Grad.	
Chem.						
Phys.				19. Choices:		
Other:				Biol.	Chem.	Math.
				Phys.	G.S.	
				Other:		
Genl. Math				20. Academic Preparation:		
Alg. I				Total Hours Credit		
Alg. II					U	G
Plane Geom.				Biol.		
Solid Geom.				Chem.		
Trig.				Phys.		
Other:				Math.		
				Earth		
				Educ.		

APPENDIX II

SUMMARY OF STATISTICAL DATA

Teaching Chemistry, but not teaching Physics	60
Teaching both Chemistry and Physics	21
Teaching Physics, but not teaching Chemistry	42
Total Teachers	123
Teaching 4 or 5 classes of Chemistry and/or Physics	9
Teaching 2 or 3 classes of Chemistry and/or Physics	34
Teaching only 1 class of Chemistry or Physics	80
Number of women	12
Number under 35	56
Number over 46	21
Number with 1-3 years of teaching experience in Chemistry and/or Physics	75
Number with 4-6 years of teaching experience in Chemistry and/or Physics	20
Number with Masters Degrees	57
Number teaching Chemistry with 24 or more hours of Chemistry	28
Number teaching Chemistry with 15 or more hours of Chemistry	32
Number teaching Physics with 20 or more hours of Physics	9
Number teaching Physics with 15 or more hours of Physics	22
Number teaching Chemistry with less than 10 hours of Chemistry	9
Number teaching Physics with less than 10 hours of Physics	13
Number having a total of 50 or more hours in Chemistry-Physics-Mathematics, with a minimum of 10 hours in each	31
Number who could be brought to that level in one properly planned summer of study	40